Examining variation in the measurement of multimorbidity in research

Title

Examining variation in the measurement of multimorbidity in research: a systematic review of 566 studies

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Abstract

Background: There is a lack of systematic understanding of how multimorbidity has been constructed and measured. This review aims to examine multimorbidity definition and measurement in research.

Methods: Systematic review registered with PROSPERO (CRD420201724090), with searches in nine bibliographic databases, from inception to 21/01/20. Reference lists of retrieved articles were hand-searched. Eligible studies measured multimorbidity for any purpose in primary care, community or hospital populations. Two reviewers independently reviewed the retrieved studies. We used descriptive analyses to understand characteristics and patterns of multimorbidity measures.

Findings: In total, 566 studies were included in this review. 36% of studies did not explicitly report how they defined multimorbidity and 13% did not report the conditions their measure included. The number of conditions included in measures ranged from 2 to 285 (median 17, interquartile range 11-23). 98% of measures included at least one cardiovascular condition, compared to at least one metabolic and endocrine (97%), respiratory (93%), musculoskeletal (88%) and mental health (79%) condition, whereas chronic infections (27%), haematological (24%), ENT (24%), skin (16%) and oral (4%) conditions were uncommonly included. Only eight individual conditions were included by more than half of studies (diabetes, stroke, cancer, COPD, hypertension, coronary heart disease, chronic kidney disease and heart failure), none of which were mental health conditions.

Interpretation: Measurement of multimorbidity is poorly reported and very variable. Consistent reporting of measure definitions should be required by journals, and consensus studies are needed to define core and optional conditions to include.

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Research in context

Evidence before this study

To identify studies relevant to multimorbidity measurement, we used two key terms (multimorbidity AND measurement) to conduct searches in Ovid interface (PsycINFO, Embase, Global Health, Medline), Scopus, Web of Science, Cochrane Library, EBSCO interface (CINAHL Plus), and ProQuest Dissertations & Theses Global, from inception to 21 January 2020. Previous narrative systematic reviews examining multimorbidity measure design concluded that the number and type of conditions included in multimorbidity counts varies, but only include small numbers of studies with incomplete searching. Other reviews examined the performance of weighted indices in predicting one or more outcomes, concluding that the Charlson Comorbidity Index and Elixhauser's Comorbidity Index had better predictive performance for mortality, the Health-related Quality of Life Comorbidity Index for quality of life, Bayliss's weighted index for physical functioning and self-rated health, and the Adjusted Clinical Group System and medication-based indices for healthcare use and costs. However, differences in predictive performance between measures (including between weighted indices and simple counts of conditions) were small.

Added value of this study

This review is larger than any previous review, and systematically examines variation in reporting and measurement of multimorbidity. It identifies very considerable variation in how multimorbidity is measured in the research literature, particularly in relation to the number and nature of conditions included in different studies.

Implications of all the available evidence

Multimorbidity research has been growing rapidly over the past decade, but the literature is characterised by poor reporting and variation in the number and nature of the conditions included in measurement. Reporting would be improved by journals requiring studies to clearly report which conditions they included in measurement and why they chose those conditions, and codesets or clear definitions of how each individual condition was ascertained. There is a need for consensus on defining a core condition set for multimorbidity measurement for all studies to report to facilitate comparison across studies, and for guidance on principles for defining bespoke condition sets justified by purpose or context. Based on this analysis, we recommend a potential core set of conditions to include in all measures, and when other conditions should be considered for inclusion. Further consensus studies are needed.

Introduction

Due to increasing longevity and better survival from acute conditions, the number of people living with multiple long term health conditions is rising.[1] The UK Academy of Medical Sciences (2018)[2] defines multimorbidity as the co-existence of two or more health conditions in a population, each one of which should be either a long-term physical non-communicable disease, a mental health condition of long duration, or a long-term infectious disease. Multimorbidity differs conceptually from comorbidity where the focus is on any additional conditions that people with a specified index condition also have.[3] There is growing recognition that existing healthcare systems are seriously challenged by multimorbidity because they are largely designed to care for patients with single conditions, and research into multimorbidity is rapidly growing.[4,5]

Despite the growing research interest in multimorbidity, how it is defined and measured varies substantially. Several previous studies have examined the definition and measurement of multimorbidity.[6] Although there is agreement that multimorbidity is common and often burdensome, varying operational definitions of multimorbidity are recognized to have led to heterogeneous estimates of multimorbidity prevalence and burden.[6-9] Operational definitions differ in terms of the number and types of conditions included, the cut-off point for defining when multimorbidity is present, whether conditions are simply counted or are weighted in relation to pre-defined outcomes, and the data sources and data collection methods used.[6,8,10-13] There is therefore no clear consensus on how to measure multimorbidity including which conditions to use in any measure.[6,7,14] This makes comparison across research studies difficult because the underlying measure used by each study can be very different.

The aim of this systematic review was to examine how multimorbidity has been measured in peer-reviewed studies internationally, including which chronic conditions are included in measures and how these vary between studies.

Methods

We systematically reviewed studies measuring multimorbidity, and examined the design and characteristics of multimorbidity measures used. The review protocol was registered with PROSPERO (CRD42020172409) and Research Registry (reviewregistry839). This paper reports findings relating to the first two registered objectives. Findings for the third registered

objective (to identify factors associated with heterogeneity of estimated multimorbidity prevalence) use different analytical approaches and will be reported separately.

In the review, we followed the CoCoPop framework (Condition, Context and Population) for systematic review of observational studies to define eligibility criteria and conduct searches.[15] The condition set for inclusion in this review is multimorbidity measurement, particularly in relation to long-term conditions. In terms of context and population, we examined studies conducted in primary care, community or hospitals where a whole sample of population was studied. Other inclusion criteria were that studies provided full text and were reported in English. This review excluded studies that focused on people with a particular condition (comorbidity) or studied within a specialist service, and studies that were conference proceeding abstracts, qualitative research or case series.

Search strategy

The search strategy was developed in collaboration with a medical librarian (Supplementary Table S1). Two sets of key terms (multimorbidity and measure) were combined with Boolean logic to search for relevant literature. Medical subject headings were used to capture concepts and maximise the number of studies retrieved. Searches were conducted in Ovid interface (PsycINFO, Embase, Global Health, Medline), Scopus, Web of Science, Cochrane Library, EBSCO interface (CINAHL Plus), and ProQuest Dissertations & Theses Global, from inception to 21/01/20. Following the database searches, we hand-searched reference lists of retrieved articles and tracked citations.

Study screening and selection

Identified references were exported to EndNote X9 and Excel software for deduplication, and then imported to Covidence software[16] for screening by two independent reviewers of titles, abstracts, and full-text articles against the eligibility criteria, with disagreement resolved by discussion and involvement of a third reviewer if necessary.

Data extraction

Data on the characteristics of the included studies were extracted using pre-designed data extraction tables. The extracted data include 1) authors; 2) year of publication; 3) study title; 4) study purpose; 5) method; 6) country; 7) study participants; 8) sample size; 9) reference definition of multimorbidity; 10) type of multimorbidity measure (simple counts or weighted

indices); 11) data collection method/data source (self-report or medical records/administrative databases); 12) number of conditions included; and 13) the actual conditions included. Due to the wide variation in labelling of conditions included, we categorised similar conditions into groups. An example of how we categorised conditions is our category of chronic pain, where one or more of the underlying studies variously counted 'neck pain', 'back pain', 'low back pain', 'chronic low back pain', 'pain', 'chronic pain', 'painful conditions', 'trigeminal neuralgia' or 'fibromyalgia'.

Risk of bias assessment

The Effective Public Health Practice Project (EPHPP) quality assessment tool for quantitative studies was used to assess risk of bias and quality of the included studies.[17] The EPHPP tool evaluates 1) selection bias, 2) study design, 3) confounders, 4) blinding, 5) data collection method, 6) withdrawals and dropouts. In addition to the six components, we further evaluated two other types of bias— publication bias and conflict of interest. Each domain was rated as low, moderate, high, or unclear risk of bias. The overall risk of bias was classified as low, moderate, or high. We also categorised each study in terms of if they clearly reported the reference definition for measuring multimorbidity and listed all health conditions included in the multimorbidity measure.

Data analysis

Descriptive analysis summarised the characteristics of multimorbidity studies and measures. Categorical data are presented as counts, as percentages, and cross-tabulated with other categorical data. Pearson's chi-square test was used to test for statistically significant differences in cross-tabulated data, and a two-sided p-value of $\leq 0{\cdot}05$ was considered statistically significant. If contingency table expected frequencies were <5, the p-value was computed for a Monte Carlo test with 2000 duplicates. Post-hoc analysis was performed for multiple comparisons where there was a statistically significant overall chi-square test.

Relationships between characteristics of multimorbidity measures and the number of conditions included in the measure were examined using negative binomial generalized linear regression (the Poisson model was found to be over-dispersed).[18] Negative binomial coefficients were exponentiated to estimate incidence rate ratios (IRR). There was 14% missingness in the dataset because of incomplete reporting by 73 underlying studies, with missingness highest for the 'number of conditions' count variable (11%), the measure types

(5%) and data sources (1%) binary variables. For the regression analysis, multiple imputation with 100 imputed datasets and 20 iterations was performed using Bayesian logistic regression to impute missing data in binary variables, and negative binomial regression for over-dispersed count data (Y).[19, 20] Number of conditions, setting, study population, data source and the type of measures used in studies were included as covariates in the imputation of incomplete data. Fraction of missing information (FMI) was computed to quantify loss of information due to missingness. With the exception of five studies measuring multimorbidity in children where FMI was 0·53 (high), FMI ranged from 0·005-0·3 (small to moderate) indicating that multiple imputation uncertainty is acceptable.

The conditions included in different studies were examined in terms of both body systems with at least one included conditions and individual conditions themselves, and compared with conditions identified as having the highest burden of Disability Adjusted Life Years the Global Burden of Disease study 2019.[21] All statistical tests were performed using R version 4·0·1.[22] Where quantitative analyses were not suitable, a narrative overview was undertaken.

Role of funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, writing of the report and the decision to submit this paper. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results

We identified 13807 articles from databases. Study selection and reasons for exclusion are summarised in Supplementary Figure S1. Overall, 566 studies were included in this review (Table 1 and Supplementary Table S3). Most studies were carried out in Europe (n=209, 37%), followed by North America (n=190, 34%), Asia (n=81, 14%) and Australasia (n=42, 7%). There were relatively few studies from South America (n=23, 4%), Africa (n=4, 1%) and multiple continents (n=17, 3%). The majority of studies were community-based (n=320, 56%) or primary care based (n=126, 22%), with the remainder in hospitals (n=104, 18%), care homes (n=14, 3%), or multiple settings (n=2, 1%). Data on multimorbidity were collected through self-report (n=312, 55%), medical records and administrative databases

(n=240, 43%), or both self-report and medical records/administrative databases (n=6, 1%). Eight studies (1%) did not report data source.

The most common stated purposes of measuring multimorbidity in the included studies were examination of its association with various outcomes (n=209, 37%) or associations with risk factors (n=75, 13%), examination of measure performance (n=117, 21%), identification of multimorbidity patterns (n=62, 11%), and examination of multimorbidity trajectories over time (n=19, 3%) (Table 1). Multimorbidity was most commonly examined in studies of all adults (n=240, 43%), of older adults (n=216, 38%) and of middle-aged and older adults (n=80, 14%), whereas very few studies measured multimorbidity in children (n=5, 1%) or in all age groups (n=7, 1%).

Defining multimorbidity. Almost half of the studies defined multimorbidity as the presence of two or more conditions (n=268, 47%), with smaller numbers using "multiple chronic conditions" (n=56, 10%), three or more conditions (n=28, 5%) or five or more (n=4, 1%). In total, 206 (36%) studies did not report any reference definition. Three studies defined severe or complex multimorbidity (using various terms) in addition to (ordinary) multimorbidity, with two studies using four or more[23,24] and one using five or more[25] chronic conditions as a cut-off point for severe.

Choice of measure type. A simple count of conditions was used to measure multimorbidity in 376 (66%) studies, 155 (27%) studies used weighted indices, 27 (5%) used both types of measures together, and eight (2%) did not report the type of measure used. Where a weighted index was used, 149 studies used a disease-based index, and six studies used a medication-based index. The most commonly used disease-based indices were various versions of the Charlson Comorbidity Index (CCI) (n=64) and the Cumulative Illness Rating Scale-Geriatric (CIRS-G) (n=25). Medication-based indices included the Chronic Disease Score (n=2),[26,27] Rx-Risk (n=2),[28,29] the Medication-based Disease Burden Index (MDBI)[30] and the Medicine Comorbidity Index.[31] Common weighting methods for indices were: 1) Use of regression models to calculate weights for each condition based on association with a particular outcome (e.g. the CCI); 2) Rating of condition severity within each category based on pre-specified levels of severity (e.g. the CIRS-G[32] and Bayliss's index[33]); and 3) Assignment of weights based on existing disease burden literature (e.g. the MDBI[30]).

Weighted multimorbidity measures were somewhat more likely to be used in studies collecting data through medical records/administrative databases (n=118, 54%), whereas simple counts of conditions were much more commonly used in studies based on self-report data (n=271, 89%; χ^2=57·00, p=0·0004) (Supplementary Table S4). The choice of measures varied depending on study purpose (χ^2=11·87, p=0·008), with weighted measures primarily used to predict outcomes. Similarly, the choice varied by study setting (χ^2=153·60, p=0·0004), with simple counts more commonly used in studies in community settings (n=269, 86%) and primary care (n=81, 74%), whereas weighted measures were predominantly used in hospital settings (n=73, 78%).

Number of conditions included in measures. Fifty-six (10%) studies did not report how many conditions were included in their multimorbidity measure, and 41 (7%) compared the performance of multiple measures in relation to outcomes. For the 469 (83%) studies examining a single measure, the number of conditions included in the measure ranged from two to 285 (median 17, interquartile range 11 to 23) (Figure 1).

Associations between study characteristics and the number of conditions included are shown in Table 2. In univariate analysis, studies measuring multimorbidity in large databases included more conditions compared to self-report, and community studies included fewer conditions than those in primary care, hospitals and care homes. Studies that included older populations included more conditions than those restricted to children or non-older adults. In the full model, database studies were estimated to include more than twice as many conditions as self-report studies (IRR 2·2, 95%CI 1·8-2·6). Study setting and study population were not significantly associated with the number of conditions included in the measure in the adjusted model.

Choice of conditions included in measures. Seventy-three (13%) studies did not report which health conditions were included in a measure, and 41 (7%) compared the predictive performance of multiple measures in relation to outcomes. In the remaining 452 studies, 98% of measures included at least one cardiovascular condition, followed by including at least one metabolic and endocrine (97%), respiratory (93%), musculoskeletal (88%) and mental health (79%) condition (Figure 2). Conversely, chronic infections (27%), haematological (24%), Ear Nose and Throat (ENT, 24%), skin (16%), oral (4%) and congenital conditions (3%) were only included by a minority of studies.

In respect to individual health conditions (Supplementary Figure S2), strikingly, only eight conditions were included in the multimorbidity measure used in more than half of studies. Diabetes was included in 91% of studies, with smaller proportions including stroke (79%), cancer (77%), chronic obstructive pulmonary disease (COPD) (71%), hypertension (70%), coronary heart disease (61%), chronic renal disease (53%) and heart failure (51%). By contrast, health conditions included in less than 3% of studies were eating disorder (3%), aneurysm (3%), malnutrition (3%), fluid and electrolyte disorder (3%), dissociative or personality disorder (2%), post-traumatic stress disorder (PTSD) (2%), obsessive compulsive disorder (OCD) (2%), sleep apnoea (1%), chronic fatigue syndrome (1%) and attention deficit hyperactivity disorder (ADHD) (1%).

No individual mental health condition was included by more than half of studies. Multimorbidity measures included both physical and mental health conditions in 331 studies (73%), only physical conditions in 115 studies (25%), and only mental health conditions in six studies (1%). In studies including both, measures usually only included a small number of mental health conditions, most commonly depression (49%), dementia (44%) and anxiety (22%). All other mental health conditions, including schizophrenia, alcohol and drug dependence and bipolar disorder, were included in less than 20% of studies.

No difference was found in the choice of conditions between studies from low middle-income and high-income countries. Tuberculosis was the only condition where there was statistically significant variation in inclusion in measures by location. Results from chi-square post-hoc test indicated that tuberculosis was more commonly included in multimorbidity measures in Asia (14/68, p=0·001) compared to Africa (1/3), and Australasia (5/32) Europe (8/163), North America (5/150) and South America (1/22) ($\chi^2 = 21{\cdot}62$).

Disease burden and inclusion in measures. Table 3 and Supplementary Figure S3 shows how often conditions with the highest global burden of Disability Adjusted Life Years (DALYs) and Years of Life Lost (YLL) [21] were included in multimorbidity measures. Of the top 10 conditions by DALYs burden, coverage in multimorbidity measures ranged from 8 to 91%. For the top 11 to 25 conditions by DALYs burden, coverage ranged from 4 to 53%. Conditions in the top 25 of DALYs burden but only included in <30% of multimorbidity measures were tuberculosis, malnutrition, HIV/AIDS, chronic skin conditions, migraine, ear

disease, gynaecological disorder, anxiety, oral disorder, consequences of injuries, osteoarthritis and drug use.

Of the 566 articles measuring multimorbidity, the majority of studies (n=419) were rated to be of moderate risk of bias, 107 high risk of bias, and 40 low risk of bias (Supplementary Table S5). There was a statistically significant relationship between the overall risk of bias evaluated using the EPHPP criteria and the clarity of reporting of multimorbidity measurement (χ^2 =116·64, p=0·0004), with studies clearly reporting multimorbidity measurement being less likely to be at high risk of bias (7% vs 44% of those not clearly reporting) and more likely to be low risk of bias (9% vs 2%) (Supplementary Table S6).

Discussion

In this review, over a third of studies did not explicitly report their definition of multimorbidity. Where explicitly reported, the most common definition used was two or more conditions, with small numbers using three or more, or five or more as cut-offs. One in ten studies did not state the number or nature of the conditions included in a measure. The number of conditions included in multimorbidity measures ranged from 2 to 285 (median 17, interquartile range 11-23). Approximately 66% of studies used a simple count for multimorbidity measurement (for a range of study purposes), whilst almost 30% of studies measured multimorbidity using weighted indices (mainly for predicting outcomes).

Studies which reported the conditions included in their multimorbidity measure varied in which conditions they counted. More than 90% of studies included at least one cardiovascular, metabolic and endocrine or respiratory condition, but chronic infections, haematological, ENT, skin, oral and congenital conditions were included by less than one third of studies. Only eight individual conditions were included in measures used by more than half of studies, all of which were physical health conditions (diabetes, stroke, malignancy, hypertension, COPD, coronary heart disease, chronic renal disease and heart failure).

No mental health condition was included in more than half of studies and a quarter did not include any mental health condition, which identifies a clear gap in the literature. Mental and physical multimorbidity has been well recognised to have collective effects on mortality, quality of life, disability and patient activation.[34-36] The inclusion of mental health conditions,

such as depression, dementia, anxiety disorder, and schizophrenia will usually be required to properly understand multimorbidity impact.

Previous narrative systematic reviews on multimorbidity measurement focused on the comparison of how well different weighted indices predict one or more outcomes including mortality and health care utilisation.[10,37-39] Studies were found to commonly use a weighted index where the purpose is to predict outcomes[13,39], and Stirland et al.[39] in their recent systematic review provide recommendations on which weighted index to use for a particular outcome of interest. Although simple counts with the cut-off of two or more conditions are commonly used,[40] this definition has been criticised as failing to identify people with the highest needs.[41] However, in practice the predictive validity of weighted indices and a simple count often only differs slightly.[42-43] Beyond counting, recent literature has suggested a shift of focus to better understand the impact of particular disease clusters on clinical outcomes.[2,44]

We identified that a significant minority of studies did not report how they defined and measured multimorbidity. At a minimum, we believe that all studies of multimorbidity need to clearly report: 1) Their core multimorbidity definition, and whether measured by a simple count or a weighted index; 2) Which conditions are included in the measure; 3) Why these conditions were selected in relation to the purpose of the study; and 4) How each condition is defined including any codesets used.

Clear reporting is essential, but our study also found very large variation in the number and nature of the conditions included in multimorbidity measures. The optimal conditions to include are likely to vary somewhat by study context and purpose, but we believe there is value in identifying a core set of conditions which all studies should include, and factors which might then influence choice of other conditions. We recognise that there is no reason in principle to exclude any condition from morbidity counts, and that rare diseases are cumulatively common, but identifying rare conditions in routine data is problematic, and self-report studies are limited by concerns for participant burden and the use of relatively general condition categories that people choose from.[45] Related to this, there is often uncertainty about when to count condition subgroups separately (eg myocardial infarction, angina) or in more heterogenous groups (eg coronary artery disease). The 67 conditions we defined based on the 566 international studies provide insight and along with consideration of conditions with DALYs or YLL, provide a potential core list to pick from but we recognise that

researchers may vary from this depending on their purpose. Based on this analysis, Figure 3 suggests a minimal core list of 20 conditions and considerations for choosing other conditions, but there is a need for consensus studies to refine choices.

The key strengths of this review include comprehensive database searches, assessment of risk of bias, robust analysis and the systematic examination of multimorbidity measurement in a large number of studies. Limitations, include that labelling of relevant studies was inconsistent, meaning that not all relevant studies are likely to have been included, although this is unlikely to alter the overall conclusion that measurement is poorly reported and highly variable. There was also considerable variation in how different conditions were named or grouped by multimorbidity measures, which meant that for synthesis we had to group or combine some conditions which the underlying studies kept distinct. The likely consequence is that true heterogeneity of measurement is larger than we observed.

To conclude, this review finds that many studies fail to clearly report how they measured multimorbidity. Consistent reporting of measure definitions and condition definitions should be required by journals. Where reported, measurement of multimorbidity is very variable. There is need for consensus to identify core condition sets that all studies should measure (to facilitate comparison and synthesis across studies), and study purposes and contexts when other condition sets will be appropriate.

Contributors

All authors have made substantial contributions: CMC, KN, UK, KK, RAL, JD, CB, AA, AAL and SM were involved in conception of the work, acquisition of funding, and critically commenting on the manuscript. IH and BG contributed to the design, analysis, and interpretation of data for the review, and are responsible for the decision to submit the manuscript. IH and PH screened and reviewed retrieved studies. All authors contributed to the edits of the manuscript and had access to the data. The final draft has been approved by all authors.

Competing interests

The authors declare no competing interests

Data sharing

Study data are available on request to the authors.

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Figure titles

Figure 1: Distributions of the number of conditions

Figure 2: Long-term conditions included in multimorbidity measurement (Supplementary Figure S1 shows the 67 conditions in descending order)

Figure 3: A potential core list of 20 conditions and considerations for choosing other conditions

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Table 1: Study characteristics (see Supplementary Table S2 for the definition of variables)

Study characteristic	No. (%) of studies N=566
Study setting	
Community	320 (56%)
Primary Care	126 (22%)
Hospital	104 (18%)
Care Home	14 (3%)
Primary care and hospitals	2 (1%)
Data source	
Self-report or interviews	312 (55%)
Medical records and administrative databases	240 (43%)
Self-report and medical records/administrative databases	6 (1%)
Unclear	8 (1%)
Study population	
All adults	240 (43%)
Only children	5 (1%)
Adults but not older people	10 (2%)
Only middle-aged	8 (1%)
Middle-aged and older	80 (14%)
Only older people	216 (38%)
Whole population	7 (1%)
Primary study purpose	
Association of multimorbidity with outcome	209 (37%)
Association of risk factors with multimorbidity	75 (13%)
Patterns or clusters of multimorbidity	62 (11%)
Trajectory of multimorbidity	19 (3%)
Examination of measures	117 (21%)
Study of people with multimorbidity	68 (12%)
Other	16 (3%)
Definition of MM/cut-offs	
Not reported	206 (36%)
Two or more chronic conditions	268 (47%)
Three or more chronic conditions	28 (5%)
Five or more chronic conditions	4 (1%)
Multiple chronic conditions	56 (10%)
Patient-defined weighted cumulative score	4 (1%)
Type of multimorbidity measure	
Simple counts	376 (66%)
Weighted index of conditions	149 (26%)
Weighted index of medications	6 (1%)
Both simple counts and weighted indices	27 (5%)
Unclear	8 (2%)
No. of conditions	
Not reported	56 (10%)
≤10	104 (18%)
11-20	224 (40%)
21-30	68 (12%)
31-40	33 (6%)
41-50	15 (3%)
>50	25 (4%)
Not applicable (studies that examined multiple measures)	41 (7%)

Table 2: Relationships between the number of conditions included in the multimorbidity measure and other study characteristics

Predictors	Mean no. of conditions (SD)	Unadjusted IRR (95%CI)	Adjusted IRR (95%CI)	FMI
Data source				
Self-report	16 (11)	Ref	Ref	Ref
Databases	32 (41)	1·8 (1·6-2·0)	2·2 (1·8-2·6)	0·12
Settings				
Community	19 (20)	Ref	Ref	Ref
Primary care	26 (27)	1·3 (1·1-1·5)	0·9 (0·8-1·1)	0·11
Hospitals	27 (34)	1·5 (1·2-1·7)	1·1 (0·9-1·3)	0·10
Care homes	43 (77)	2·3 (1·5-3·4)	1·4 (1·0-2·2)	0·16
Population				
All adults	25 (32)	Ref	Ref	Ref
Only children	6 (1)	0·3 (0·1-0·9)	0·4 (0·1-1·1)	0·53
Adults but not older people	12 (4)	0·5 (0·3-0·9)	0·6 (0·4-1·0)	0·19
Only middle-aged	14 (11)	0·6 (0·3-1·2)	0·6 (0·3-1·0)	0·30
Middle-aged and older	24 (40)	0·9 (0·8-1·2)	1·0 (0·9-1·2)	0·07
Only older people	19 (12)	0·8 (0·7-0·9)	0·9 (0·7-1·0)	0·11
Whole population (from birth)	28 (11)	1·2 (0·7-2·0)	1·3 (0·8-2·1)	0·09
Type of measure				
Simple counts	21 (30)	Ref	Ref	Ref
Weighted measures	25 (17)	1·2 (1·0-1·4)	1·7 (1·3-2·2)	0·04
Interaction				
Weighted measures: Databases			0·4 (0·3-0·5)	0·09

Ref= Reference category. FMI: Fraction of missing information

Table 3: Conditions with highest global burden of Disability Adjusted Life Years (DALYs) and Years of Life Loss (YLL)

Condition (ranked in descended order of attributable DALYs)	Attributable age-standardised DALYs per 100,000 people (both sexes combined)	Attributable age-standardised Years Life Lost per 100,000 people		Percentage of multimorbidity studies including condition in measurement
		Women	Men	
Injuries	3,170	1,360	3,390	27%
Cancer	3,060	2,490	3,520	77%
Coronary heart disease	2,240	1,580	2,820	61%
Tuberculosis	2,090	385	692	8%
Stroke	1,770	1,290	1,840	79%
COPD	926	499	902	71%
Diabetes	859	384	452	91%
Chronic pain	780	Not estimated	Not estimated	31%
Malnutrition	680	151	163	3%
HIV/AIDS	598	564	533	23%
Depression	578	Not estimated	Not estimated	49%
Chronic liver disease	560	337	773	49%
Chronic skin condition	559	29.2	29.1	16%
Migraine	526	Not estimated	Not estimated	16%
Chronic renal disease	515	350	470	53%
Ear disease	499	Not estimated	Not estimated	22%
Gynaecological disorder	368	6.75	Not estimated	4%
Anxiety	360	Not estimated	Not estimated	22%
Dementia	339	254	220	44%
Oral disorder	285	Not estimated	Not estimated	4%
Vision impairment	278	Not estimated	Not estimated	37%
Asthma	274	140	142	41%
Heart failure (inc. hypertensive heart disease)	268	239	258	51%
Osteoarthritis	228	Not estimated	Not estimated	18%
Drug use	225	38.7	106	13%
Alcohol use	207	20.9	131	16%
Congenital disease	194	648	747	3%
Schizophrenia	184	Not estimated	Not estimated	17%
Upper digestive track disease	183	62·7	98·3	41%
Anaemia	172	69	70·6	17%
Epilepsy	171	57·6	81·2	17%
Valvular disease (inc. rheumatic heart disease)	113	114	101	10%
Arrhythmia	107	49·8	49·9	23%
Bipolar disorder	105	Not estimated	Not estimated	6%
Chronic bowel disease	93	76·5	106	20%
Parkinson's disease	80	47·6	88	23%
Gall bladder	78	29·7	28·2	7%
Learning disability	58	Not estimated	Not estimated	6%
Pancreatic disease	44	24·	59·3	6%
Aneurysm	41	24·6	59·5	3%
Connective tissue disease	40	13	7·11	35%
Gout	20	Not estimated	Not estimated	9%
Peripheral arterial disease	20	9·85	17·2	41%
Multiple sclerosis	14	9·84	7·13	8%

Data on DALYs were derived from the supplementary appendices of Vos et al.[21] (Supplementary Figure S3). DALYs comprise the estimates of years of life loss due to premature mortality (YLL) and years lived with disability (YLD). Vos et al[21] report DALYs as a combined burden, but YLL by gender. Conditions relating to consequences of injury in this study include paralysis (from causes other than stroke) (17%) and long-term musculoskeletal impairment due to injury (10%)

Potential core conditions with high DALYs and/or high YLL

1. Cancer
2. Coronary artery disease
3. Stroke
4. Heart failure
5. Diabetes
6. Dementia
7. Depression
8. Schizophrenia
9. Anxiety
10. Alcohol and drug misuse
11. Chronic liver disease
12. Chronic renal disease
13. Chronic obstructive pulmonary disease
14. Asthma
15. Sensory impairment (vision or hearing impairment)
16. Musculoskeletal impairment due to injury
17. Paralysis (from causes other than stroke)
18. Osteoarthritis
19. Chronic pain
20. Gynaecological disorders

Potential considerations for including other conditions

Particularly relevant in some countries

- Tuberculosis
- Malnutrition
- HIV/AIDS

Particularly relevant in children

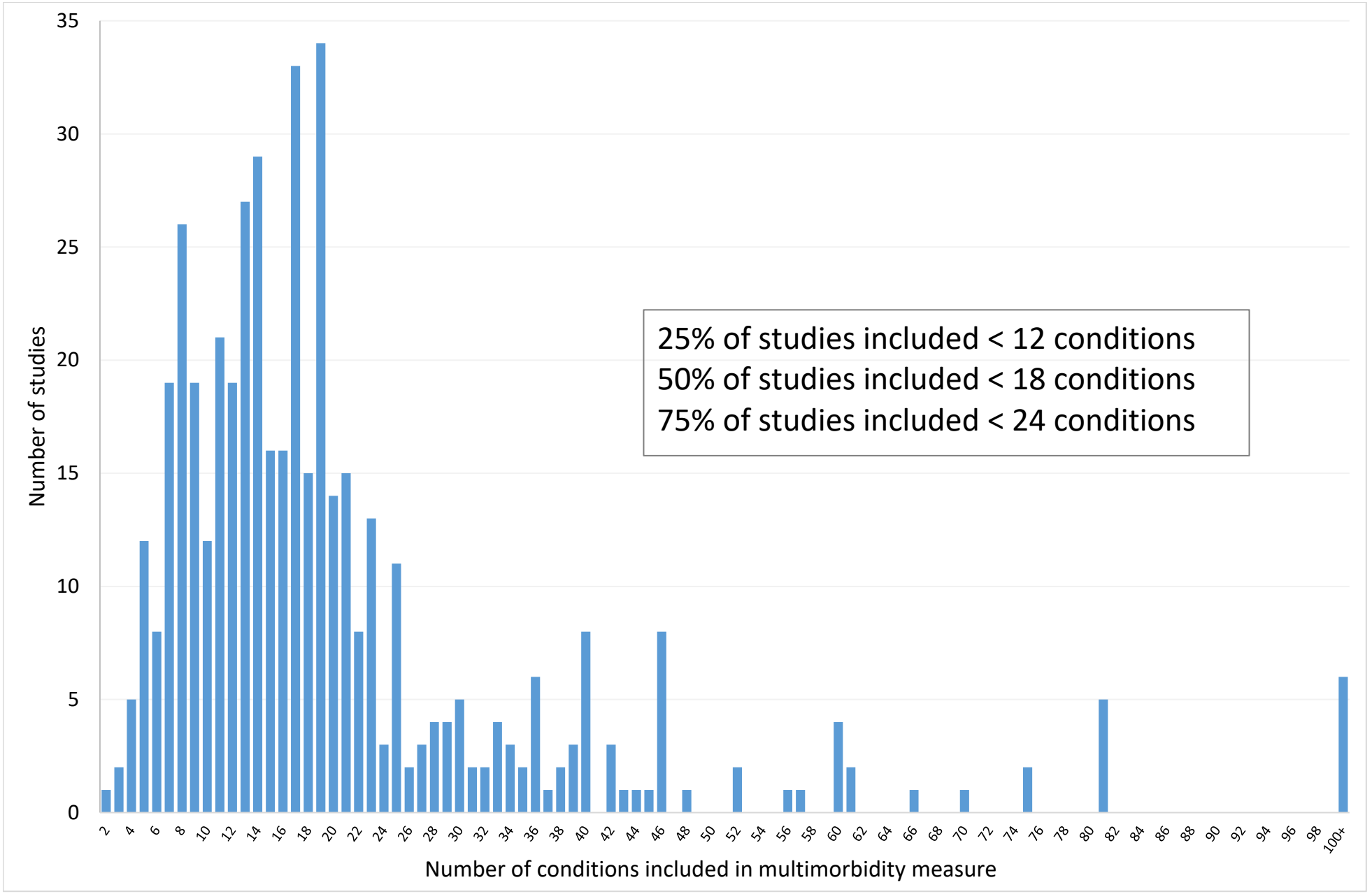
- Congenital disease
- Learning disability

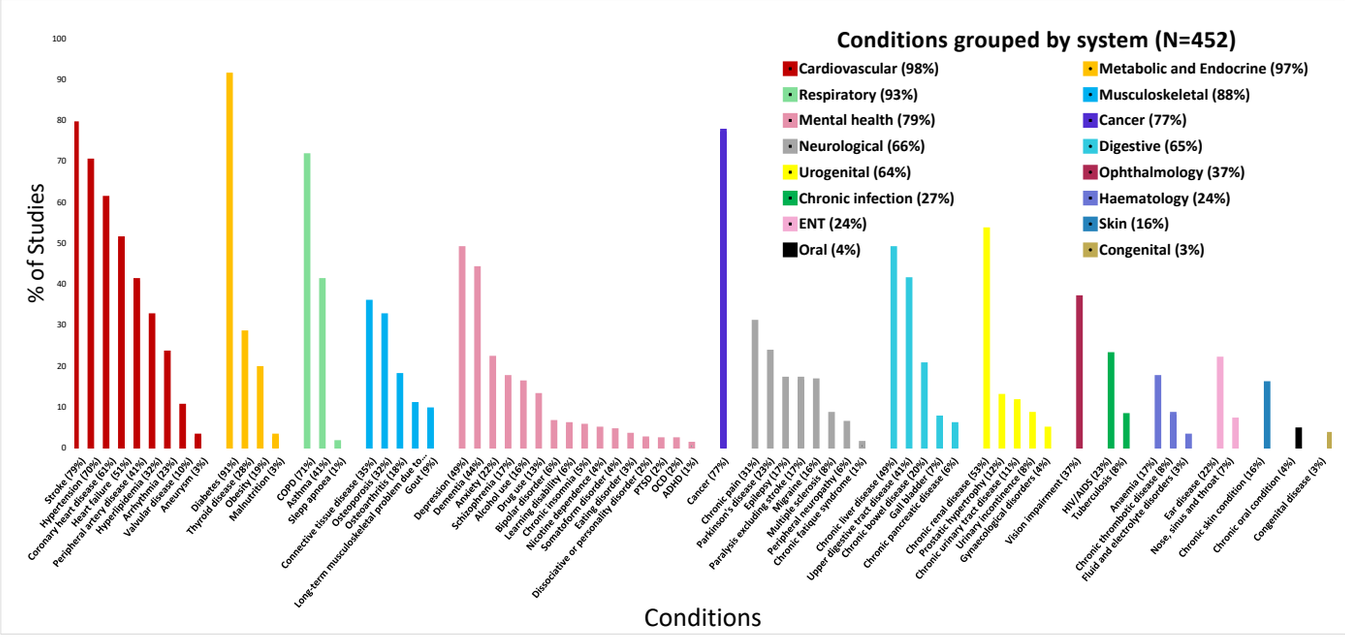
Particularly relevant if the focus is quality of life

- Eczema
- Psoriasis
- Migraine
- Oral disorders

For some purposes

- More detailed condition definition may be relevant (e.g. myocardial infarction, stable angina)
- Inclusion of rare conditions may be appropriate


25% of studies included < 12 conditions
50% of studies included < 18 conditions
75% of studies included < 24 conditions
Number of studies
Number of conditions included in multimorbidity measure


Conditions grouped by system (N=452)
Cardiovascular (98%)
Respiratory (93%)
Mental health (79%)
Neurological (66%)
Urogenital (64%)
Chronic infection (27%)
ENT (24%)
Oral (4%)
Metabolic and Endocrine (97%)
Musculoskeletal (88%)
Cancer (77%)
Digestive (65%)
Ophthalmology (37%)
Haematology (24%)
Skin (16%)
Congenital (3%)
% of Studies
Conditions
Stroke (79%)
Hypertension (70%)
Coronary heart disease (61%)
Heart failure (52%)
Peripheral artery disease (41%)
Hyperlipidemia (33%)
Arrhythmia (23%)
Valvular disease (10%)
Aneurysm (3%)
Diabetes (91%)
Thyroid disease (28%)
Obesity (19%)
Malnutrition (3%)
COPD (71%)
Asthma (41%)
Sleep apnea (1%)
Connective tissue disease (35%)
Osteoporosis (33%)
Osteoarthritis (18%)
Long-term musculoskeletal problem due to...
Gout (9%)
Depression (49%)
Dementia (44%)
Anxiety (22%)
Schizophrenia (17%)
Alcohol use (16%)
Drug use (13%)
Bipolar disorder (8%)
Learning disability (6%)
Chronic insomnia (5%)
Nicotine dependance (4%)
Somatoform disorder (4%)
Eating disorder (3%)
Dissociative or personality disorder (2%)
PTSD (2%)
OCD (2%)
ADHD (1%)
Cancer (77%)
Chronic pain (31%)
Parkinson's disease (23%)
Epilepsy (17%)
Paralysis excluding stroke (17%)
Migraine (16%)
Multiple sclerosis (8%)
Peripheral neuropathy (6%)
Chronic fatigue syndrome (1%)
Chronic liver disease (49%)
Chronic kidney disease (41%)
Upper digestive tract disease (20%)
Gall bladder (7%)
Chronic bowel disease (6%)
Chronic pancreatic disease (6%)
Chronic renal disease (53%)
Prostatic hypertrophy (12%)
Chronic urinary tract disease (11%)
Urinary incontinence (8%)
Gynaecological disorders (4%)
Vision impairment (37%)
HIV/AIDS (23%)
Tuberculosis (8%)
Anaemia (17%)
Chronic thrombotic disease (8%)
Fluid and electrolyte disorders (3%)
Ear disease (22%)
Nose, sinus and throat (7%)
Chronic skin condition (16%)
Chronic oral condition (4%)
Congenital disease (3%)

Supplementary appendix

Supplement to: Ho ISS, Azcoaga-Lorenzo A, Akbari A, et al. Examining variation in the measurement of multimorbidity in research: a systematic review of 566 studies.

Table of Contents

Table S1: Search strategy

Database	Search strategy
Ovid Interface PsycINFO Embase Global Health Ovid MEDLINE	1. (multimorbidit$ or multi-morbidit$ or comorbidit$ or co-morbidit$ or polymorbidit$ or poly-morbidit$ or multicondition$ or multicondition$ or "multiple chronic condition$" or "morbidity burden" or ((multiple or coexisting or co-existing or concurrent or con-current or comorbid or co-morbid) adj2 (disease$ or illness$ or condition$ or diagnos$ or morbid$))).m_titl. 2. (measure$ or index or indices or instrument$ or scale$ or "disease count$").mp. 3. 1 and 2 4. Limit 3 to human
EBSCO Interface CINAHL Plus	1. MM (multimorbidit* or multi-morbidit* or comorbidit* or co-morbidit* or polymorbidit* or poly-morbidit* or multicondition* or multicondition* or "multiple chronic condition*" or "morbidity burden" or ((multiple or coexisting or co-existing or concurrent or con-current or comorbid or co-morbid) N2 (disease* or illness* or condition* or diagnos* or morbid*))) 2. AB (measure* or index or indices or instrument* or scale*) 3. 1 AND 2 Limiters – Full Text; Human; Language: English
Scopus	TITLE (multimorbidit* or multi-morbidit* or comorbidit* or co-morbidit* or polymorbidit* or poly-morbidit* or multicondition* or multicondition* or "multiple chronic condition*" or "morbidity burden" or ((multiple or coexisting or co-existing or concurrent or con-current or morbid or co-morbid) W/2 (disease* or illness* or condition* or diagnos?s or morbid*))) AND TITLE (measure* or index or indices or instrument* or scale* or "disease counts")
Web of Science	(TI=(measure* or index or indices or instrument* or scale*))AND (TI=(multimorbidit* or multi-morbidit* or comorbidit* or co-morbidit* or polymorbidit* or poly-morbidit* or multicondition* or multicondition* or 'multiple chronic condition*' or 'morbidity burden' or ((multiple or coexisting or co-existing or concurrent or con-current or comorbid or co-morbid) NEAR/2 (disease* or illness* or condition* or diagnos* or morbid*)))) AND LANGUAGE: (English)
Cochrane library	(multimorbidity or multi-morbidity or comorbidity or co-morbidity or polymorbidity or poly-morbidity or multicondition or multicondition or 'multiple chronic conditions' or 'morbidity burden' or ((multiple or coexisting or co-existing or concurrent or con-current or comorbid or co-morbid) NEAR/2 (disease or illness or condition or diagnosis or morbid))) AND (measure or index or indices or instrument or scale or "disease count*"):ti
ProQuest Dissertations & Theses Global	ti((multimorbidit* OR multi-morbidit* OR comorbidit* OR co-morbidit* OR polymorbidit* OR poly-morbidit* OR multicondition* OR multicondition* OR 'multiple chronic condition*' OR 'morbidity burden' OR ((multiple OR coexisting OR co-existing OR concurrent OR con-current OR morbid OR co-morbid) NEAR/2 (disease* OR illness* OR condition* OR diagnos?s OR morbid*)))) AND noft((measure* OR index OR indices OR instrument* OR scale*)) Limited by: Manuscript type: Doctoral dissertations, Master's theses Language: English

Figure S1: Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flow diagram

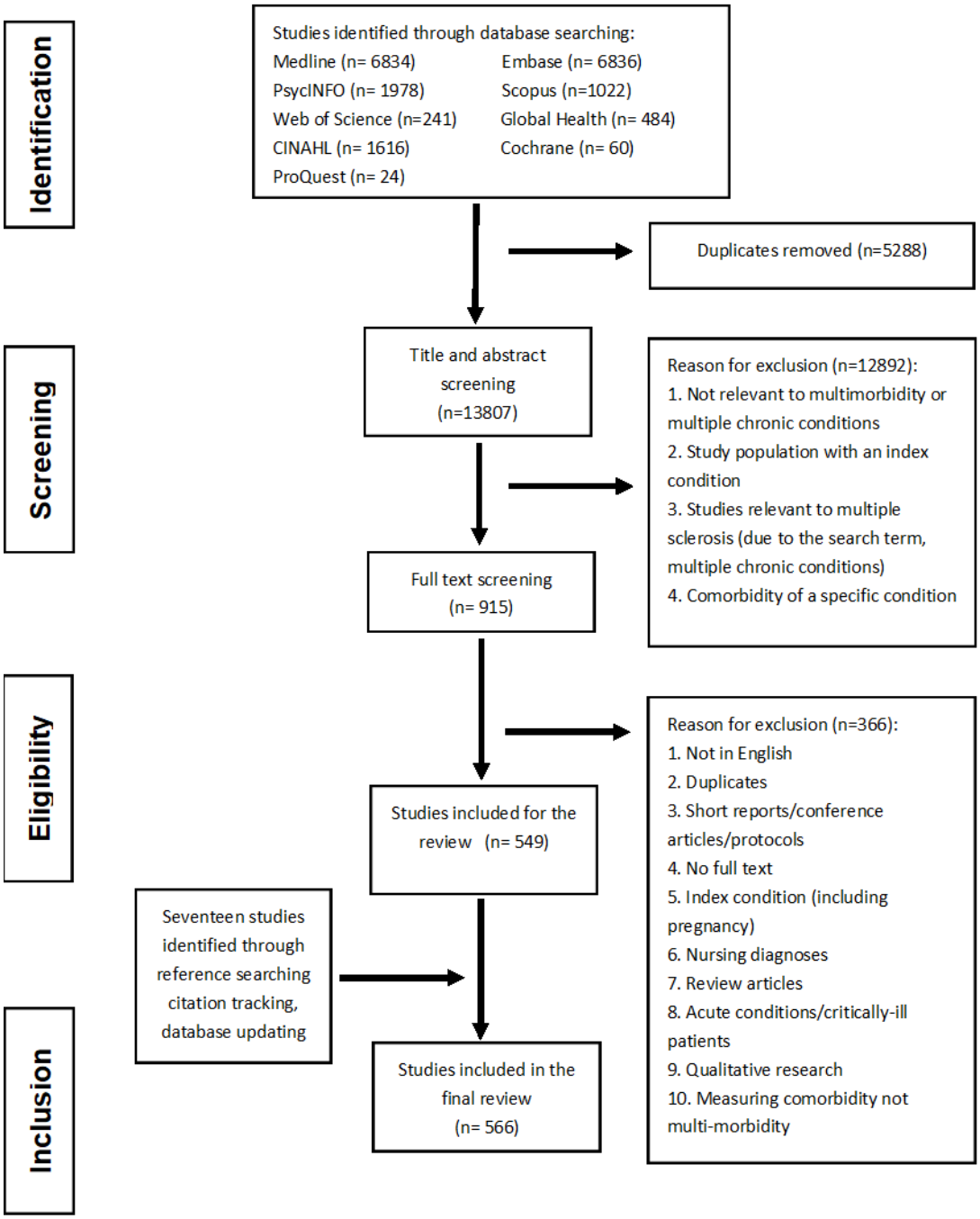


Table S2: Definition of variables

Variable name	Definition
Study setting	
Community	Studies that used population surveys, insurance claims databases, or research databases
Primary care	Studies that were carried out in primary care settings
Hospital	Studies that were carried out in hospital settings
Care home	Studies that were carried out in care homes, long-term care facilities, or nursing homes
Data source	
Self-report	Studies that collected data using self-report or interviews
Medical records and administrative databases	Studies that collected data using electronic medical records, medical chart reviews, insurance claims databases, pharmacy databases, or research databases
Study population	
All adults	Studies with a sample of population aged 18 and older (n=139), aged 17 and older (n=2), aged 16 and older (n=6), aged 15 and older (n=7), or others (n=86) (e.g. aged 20 and older, aged 21 and older, or aged 25 and older)
Only children	Studies with a sample of population aged 18 and younger
Adults but not older people	Studies with a sample of population aged between 18 and 64
Only middle-aged	Studies with a sample of population aged between 45 and 65 (n=3), aged between 40 and 65 (n=2), or others (n=3) (e.g. age between 50 and 64, age between 51 and 56, or age between 55 and 65)
Middle-aged and older	Studies with a sample of population aged 50 and older (n=38), aged 40 and older (n=11), or others (n=31) (e.g. aged 52 and older, aged 55 and older, aged 56 and older, or aged 57 and older)
Only older people	Studies with a sample of population aged 65 and older (n=111), aged 60 and older (n=49), or others (n=56) (e.g. aged 70 and older, aged 75 and older, aged 80 and older, or aged 85 and older)
Whole population	Studies with a sample of all age population
Primary study purpose	
Association of multimorbidity with outcome	Studies that aimed to examine the association of multimorbidity with one or multiple outcomes
Association of risk factors with multimorbidity	Studies that aimed to examine the association of risk factors with multimorbidity
Patterns or clusters of multimorbidity	Studies that aimed to identify patterns or clusters of diseases
Trajectory of multimorbidity	Studies that focused on the trends of multimorbidity prevalence or development of multimorbidity over time
Examination of measures	Studies that 1) examined the performance of multimorbidity measures (including the development, validation or adaptation of a measure) 2) compared the predictive performance for different measures in relation to outcomes 3) examined different multimorbidity definitions and how these affected estimates of multimorbidity prevalence 4) examined the difference in measure performance between self-report and medical records/administrative databases
Study of people with multimorbidity	Studies that focused on multimorbid populations
Other	Studies that merely aimed to estimate the prevalence or burden of multimorbidity (without examining its association with risk factors or outcomes).

Table S3: Study characteristics

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[1] Aaby et al. (2019)	2019	Associations of MM with outcome	Denmark	Europe	Community	All adults	3+	Simple counts of diseases	Simple counts of diseases	Self-report	19	No
[2] Aarts et al. (2012)	2012	Associations of MM with outcome	The Netherlands	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	23	Yes
[3] Aarts et al. (2011)	2011	Associations of MM with outcome	The Netherlands	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[4] Aarts et al. (2011)	2011	Associations of MM with outcome	The Netherlands	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	23	Yes
[5] Abizanda et al. (2014)	2014	Associations of MM with outcome	Spain	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	14	Yes
[6] Agborsangaya et al. (2012)	2012	Associations of MM with outcome	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes
[7] Agborsangaya et al. (2013)	2013	Associations of risk factors with MM	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes
[8] Agborsangaya et al. (2014)	2014	Associations of MM with outcome	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[9] Ahrenfeldt et al. (2019)	2019	Associations of risk factors with MM	Europe	Europe	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[10] Alimohammadian et al. (2017)	2017	Associations of risk factors with MM	Iran	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[11] Alwhaibi et al. (2015)	2015	Associations of MM with outcome	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[12] Angst et al. (2002)	2002	Patterns of MM	Switzerland	Europe	Primary care	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	10	Yes
[13] Appa et al. (2014)	2014	Associations of MM with outcome	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes
[14] Adams (2017)	2017	Study of people with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[15] Adams et al. (2017)	2017	Examination of MM measures	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[16] Ahmadi et al. (2016)	2016	Associations of risk factors with MM	Iran	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[17] Ahn et al. (2017)	2017	Study of people with MM	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[18] Alonso et al. (2011)	2011	Associations of MM with outcome	15 countries (Developing: Colombia, Lebanon, Nigeria, Mexico, Peoples' Republic of China, Ukraine; Developed: Belgium, France, Germany, Italy, Israel, Japan, Netherlands, Spain, and United States of America)	Multiple continents	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	19	Yes
[19] Alonso-Moran et al. (2015)	2015	Associations of MM with outcome	Spain	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	52	Yes
[20] Alwhaibi et al. (2015)	2015	Associations of MM with outcome	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[21] Amaral et al. (2018)	2018	Associations of MM with outcome	Brazil	South America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[22] An et al. (2016)	2016	Associations of risk factors with MM	South Korea	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[23] Andersson et al.(2018)	2018	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[24] Andrade et al. (2010)	2010	Patterns of MM	Brazil	South America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	23	Yes
[25] Andrews et al. (2001)	2001	Associations of MM with outcome	Australia	Australasia	Community	All adults	3+	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes
[26] Araujo et al. (2018)	2018	Associations of MM with outcome	Brazil	South America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[27] Adeniji et al. (2015)	2015	Associations of MM with outcome	UK	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[28] Arnold-Reed et al. (2018)	2018	Patterns of MM	Australia	Australasia	Primary care	All adults	2+	Simple count of diseases and severity scale (CIRS-G)	Both simple counts and weighted measure	Medical records and administrative database	43	Yes
[29] Arokiasamy et al. (2015)	2015	Associations of MM with outcome	6 low middle income countries (China, Ghana, India, Mexico, Russia, South Africa)	Multiple continents	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[30] Ashworth et al. (2019)	2019	Trajectory of MM	UK	Europe	Primary care	All adults	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	12	Yes
[31] Arfken et al. (1998)	1998	Associations of MM with outcome	USA	North America	Hospitals	Only older people	NA	Deyo CCI	Weighted index	Medical records and administrative database	17	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[32] Assari et al. (2015)	2015	Associations of MM with outcome	15 countries (China, Costa Rica, Puerto Rico, USA, Mexico, Argentina, Barbados, Brazil, Chile, Cuba, Uruguay, India, Ghana, South Africa, Russia)	Multiple continents	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[33] Assari et al. (2019)	2019	Associations of MM with outcome	USA	North America	Community	Middle aged and older	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[34] Aubert et al. (2019)	2019	Patterns of MM	Switzerland	Europe	Hospitals	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	285	Yes (incomplete)
[35] Holden et al. (2011)	2011	Patterns of MM	Australia	Australasia	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	23	Yes
[36] Violan et al. (2013)	2013	Examination of MM measures	Spain	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	27	Yes
[37] Sinnige et al.(2015)	2015	Patterns of MM	The Netherlands	Europe	Primary care	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	29	Yes
[38] Christofoletti et al.(2018)	2018	Associations of risk factors with MM	Brazil	South America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	3	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[39] Aubert et al. (2019)	2019	Patterns of MM	USA, Swizerland, Israel	Multiple continents	Care homes	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	285	Yes (incomplete)
[40] Aubert et al.(2020)	2020	Examination of MM measures	USA, Swizerland, Israel	Multiple continents	Care homes	All adults	2+	Simple count of diseases, deyo CCI, CCS (Clinical Classificaion Software), Elixhauser	Both simple counts and weighted measure	Medical records and administrative database	285	NA
[41] Cornish et al.(2013)	2013	Associations of risk factors with MM	UK	Europe	Primary care	Only children	2+	Simple count of diseases and ACG (Adjusted Clinical Groups)	Both simple counts and weighted measure	Medical records and administrative database	Unclear	No
[42] Zemedikun et al.(2018)	2018	Patterns of MM	UK	Europe	Community	Only middle-aged	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	36	Yes
[43] Wensing et al. (2001)	2001	Associations of MM with outcome	The Netherlands	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	25	Yes
[44] Forjaz et al.(2015)	2015	Associations of MM with outcome	Spain	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[45] Prazeres et al.(2016)	2016	Associations of MM with outcome	Portugal	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	14	Yes
[46] Mounce et al.(2018)	2018	Associations of risk factors with MM	UK	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[47] Taylor et al.(2010)	2010	Associations of MM with outcome	Australia	Australasia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[48] Vancampfort et al.(2019)	2019	Associations of MM with outcome	Six low and middle income countries (China, Ghana, India, Mexico, Russia, and South Africa)	Multiple continents	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[49] Vancampfort et al.(2018)	2018	Associations of risk factors with MM	Six low and middle income countries (China, Ghana, India, Mexico, Russia, and South Africa)	Multiple continents	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[50] Aubert et al.(2016)	2016	Associations of MM with outcome	Switzerland	Europe	Primary care	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	17	Yes
[51] Autenrieth et al.(2013)	2013	Associations of risk factors with MM	Germany	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[52] Bahat et al.(2013)	2013	Other	Turkey	Asia	Primary care	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[53] Bahat et al.(2014)	2014	Other	Turkey	Asia	Primary care	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[54] Bahler et al.(2015)	2015	Associations of MM with outcome	Switzerland	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	22	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[55] Vancampfort et al.(2017)	2017	Associations of MM with outcome	44 low and middle income countries	Multiple continents	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[56] Bahrmann et al.(2019)	2019	Examination of MM measures	Germany	Europe	Hospitals	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[57] Balbale et al(2016)	2016	Study of people with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[58] Banjare et al.(2014)	2014	Associations of risk factors with MM	India	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	20	Yes
[59] Bao et al.(2019)	2019	Patterns of MM	China	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	19	Yes
[60] Barra et al.(2015)	2015	Associations of MM with outcome	USA	North America	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[61] Bayliss et al.(2015)	2015	Associations of MM with outcome	USA	North America	Hospitals	Only older people	3+	Simple count of diseases and Quan-adapted Comorbidity Index	Both simple counts and weighted measure	Self-report	10	Yes
[62] Bayliss et al.(2005)	2005	Examination of MM measures	USA	North America	Hospitals	Only older people	NA	Simple count of diseases, CCI, and Rx-risk	Weighted index	Self-report	25	Yes
[63] Bayliss et al.(2009)	2009	Examination of MM measures	USA	North America	Hospitals	Only older people	NA	Simple count of diseases, Quan comorbidity index, and CDS	Weighted index	Self-report	21	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[64] Bekic et al.(2019)	2019	Associations of MM with outcome	Croatia	Europe	Primary care	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	23	Yes
[65] Beloosesky et al.(2011)	2011	Examination of MM measures	Israel	Asia	Hospitals	Only older people	NA	Simple count of diseases and weighted indices (CCI-disease burden; CIRS-G-disease severity; Medication-based disease burden index)	Both simple counts and weighted measure	Medical records and administrative database	NA	NA
[66] Bernard et al.(2016)	2016	Associations of MM with outcome	Australia	Australasia	Hospitals	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[67] Bishop et al.(2018)	2018	Associations of MM with outcome	USA	North America	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[68] Biswas et al.(2019)	2019	Patterns of MM	Bangladesh	Asia	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	3	Yes
[69] Blakemore et al.(2016)	2016	Associations of MM with outcome	UK	Europe	Primary care	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	24	Yes
[70] Blyth et al.(2008)	2008	Associations of MM with outcome	Australia	Australasia	Community	Only older people	MCC	Simple count of diseases and comorbidity burden (having high comorbidity burden means having four or more doctor-diagnosed conditions	Simple counts of diseases	Self-report	18	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[71] Bobo et al.(2016)	2016	Patterns of MM	USA	North America	Community	Whole population	2+	Simple counts of diseases	Simple counts of diseases	Self-report	19	Yes
[72] Boeckxstaens et al.(2015)	2015	Examination of MM measures	Belgium	Europe	Primary care	Only older people	5+	Simple count of diseases; weighted indices (CCI and CIRS-G)	Simple counts of diseases	Medical records and administrative database	22	Yes
[73] Boeckxstaens et al.(2015)	2015	Examination of MM measures	Belgium	Europe	Primary care	Only older people	5+	Simple count of diseases; weighted indices (CCI and CIRS-G)	Simple counts of diseases	Medical records and administrative database	22	Yes
[74] Booth et al.(2014)	2014	Associations of risk factors with MM	UK	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	11	Yes
[75] Borson et al.(2010)	2010	Examination of MM measures	USA	North America	Community	Only older people	NA	Weighted indices (CDS and CIRS-G)	Weighted index	Self-report	NA	NA
[76] Bottle et al.(2011)	2011	Examination of MM measures	UK	Europe	Hospitals	All adults	NA	Weighted indices (CCI and Modified Elixhauser)	Weighted index	Medical records and administrative database	17 (CCI) 31 (Modified Elihause)	NA
[77] Bower et al.(2013)	2013	Associations of MM with outcome	UK	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	9	Yes
[78] Bowling et al. (2019)	2019	Associations of MM with outcome	USA	North America	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[79] Bravo (2002)	2002	Examination of MM measures	Canada	North America	Care homes	Only older people	NA	Revised weighted Charlson comorbidity index	Weighted index	Medical records and administrative database	23	Yes
[80] Brenk-Franz et al. (2017)	2017	Study of people with MM	Germany	Europe	Primary care	Middle aged and older	3+	Simple count of diseases, and CIRS-G	Both simple counts and weighted measure	Self-report	Unclear	No
[81] Brett et al. (2013)	2013	Patterns of MM	Australia	Australasia	Primary care	All adults	2+	Simple count of diseases and Severity score (CIRS-G)	Both simple counts and weighted measure	Medical records and administrative database	42	Yes
[82] Brett et al. (2014)	2014	Associations of risk factors with MM	Australia	Australasia	Primary care	All adults	2+	Simple count of diseases and Severity score (CIRS-G)	Both simple counts and weighted measure	Medical records and administrative database	42	Yes
[83] Brilleman et al. (2013)	2013	Examination of MM measures	UK	Europe	Primary care	All adults	NA	Simple count of diseases, CCI, ACG	Both simple counts and weighted measure	Medical records and administrative database	NA	NA
[84] Britt et al. (2008)	2008	Patterns of MM	Australia	Australasia	Primary care	All adults	2+	Simple count of diseases and Severity score (CIRS-G)	Both simple counts and weighted measure	Medical records and administrative database	18	Yes
[85] Broeiro-Goncalves et al. (2019)	2019	Associations of risk factors with MM	Portugal	Europe	Hospitals	All adults	2+	Simple count of diseases and CCI	Both simple counts and weighted measure	Medical records and administrative database	22	Yes
[86] Bruce et al. (2010)	2010	Associations of risk factors with MM	Canada	North America	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	4	Yes
[87] Buntinx et al. (2002)	2002	Examination of MM measures	Belgium	Europe	Care homes	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[88] Burgers et al. (2010)	2010	Associations of MM with outcome	France, Germany, Canada, Australia, Netherlands, New Zealand, UK, USA	Multiple continents	Community	All adults	2+	Simple count of diseases and morbidity score (Morbidity Score= N + (2* self-reported health status) -1	Both simple counts and weighted measure	Self-report	7	Yes
[89] Burke et al. (2017)	2017	Associations of MM with outcome	US, Europe, Asia	Multiple continents	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[90] Buurman et al. (2016)	2016	Patterns of MM	The Netherlands	Europe	Hospitals	Only older people	2+	Simple count of diseases and CCI	Both simple counts and weighted measure	Medical records and administrative database	35	Yes
[91] Byers et al. (2010)	2010	Patterns of MM	USA	North America	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	2	Yes
[92] Byles et al. (2005)	2005	Examination of MM measures	Australia	Australasia	Community	Only older people	NA	Simple counts of diseases, and weighted measure	Both simple counts and weighted measure	Self-report	25	Yes
[93] Byles et al. (2014)	2014	Associations of MM with outcome	Australia	Australasia	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[94] Bynum et al. (2017)	2017	Study of people with MM	USA	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	18	Yes
[95] Bynum et al. (2004)	2004	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	18	Yes
[96] Calderon-Larranaga et al. (2018)	2018	Trajectory of MM	Sweden	Europe	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	60	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[97] Calderon-Larranaga et al. (2017)	2017	Other	Sweden	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	60	Yes
[98] Calderon-Larranaga et al. (2019)	2019	Associations of risk factors with MM	Sweden	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	57	Yes
[99] Camargo-Casas et al. (2018)	2018	Associations of MM with outcome	Columbia	South America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[100] Canevelli et al. (2019)	2019	Associations of MM with outcome	Italy	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	18	Yes
[101] Capisizu et al. (2015)	2015	Study of people with MM	Romania	Europe	Primary care	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	16	Yes
[102] Caracciolo et al. (2013)	2013	Associations of MM with outcome	Sweden	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	8	Yes
[103] Caramello et al. (2019)	2019	Associations of MM with outcome	Italy	Europe	Hospitals	Middle aged and older	NA	CCI	Weighted index	Medical records and administrative database	28	Yes
[104] Carey et al. (2013)	2013	Examination of MM measures	UK	Europe	Primary care	Only older people	NA	Weighted QOF (Quality and outcome framework) score based on health records of conditions)	Weighted index	Medical records and administrative database	15	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[105] Cesari et al. (2006)	2006	Associations of MM with outcome	Italy	Europe	Community	Only older people	3+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[106] Chamberlain et al. (2020)	2020	Associations of risk factors with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	21	Yes
[107] Chan et al. (2014)	2014	Examination of MM measures	China	Asia	Hospitals	Only older people	NA	CCI	Weighted index	Medical records and administrative database	14	Yes
[108] Chapleski et al. (1997)	1997	Associations of MM with outcome	USA	North America	Community	Middle aged and older	NA	CCI	Weighted index	Self-report	21	No
[109] Chaplin et al. (2018)	2018	Study of people with MM	UK	Europe	Primary care	Only older people	3+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[110] Chapman et al. (2015)	2015	Examination of MM measures	UK	Europe	Community	All adults	NA	CCI	Weighted index	Self-report	9	Yes
[111] Charlson et al. (2007)	2007	Associations of MM with outcome	USA	North America	Hospitals	All adults	NA	Deyo CCI	Weighted index	Medical records and administrative database	17	Yes
[112] Charlson et al. (2008)	2008	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Deyo CCI	Weighted index	Medical records and administrative database	23	Yes
[113] Charlson et al. (1987)	1987	Examination of MM measures	USA	North America	Hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	19	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[114] Charlson et al. (2014)	2014	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Deyo CCI	Weighted index	Medical records and administrative database	23	Yes
[115] Chaudhry et al. (2005)	2005	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Modified CCI	Weighted index	Medical records and administrative database	12	Yes
[116] Chen et al. (2018)	2018	Associations of MM with outcome	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	33	Yes
[117] Chen et al. (2018)	2018	Associations of MM with outcome	China	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes
[118] Chen et al. (2011)	2011	Associations of MM with outcome	USA	North America	Community	All adults	3+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[119] Cheung et al. (2013)	2013	Associations of MM with outcome	Hong Kong	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	18	Yes
[120] Chin et al. (2019)	2019	Study of people with MM	Hong Kong	Asia	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	20	Yes
[121] Chong et al. (2012)	2012	Patterns of MM	Singapore	Asia	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[122] Chow et al. (2014)	2014	Study of people with MM	Hong Kong	Asia	Hospitals	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	4	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[123] Chu et al. (2018)	2018	Associations of MM with outcome	Hong Kong	Asia	Primary care	Middle aged and older	2+	Simple count of diseases, and CIRS-G severity scale	Both simple counts and weighted measure	Medical records and administrative database	40	Yes
[124] Chudasama et al. (2019)	2019	Associations of MM with outcome	UK	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	36	Yes
[125] Cimarras-Otal et al. (2014)	2014	Associations of risk factors with MM	Spain	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	20	Yes
[126] Clerencia-Sierra et al. (2015)	2015	Patterns of MM	Italy	Europe	Hospitals	Only older people	2+	ACG system	Weighted index	Medical records and administrative database	Unclear	No
[127] Chen et al. (2014)	2014	Associations of MM with outcome	Singapore	Asia	Hospitals	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[128] Chen et al. (2019)	2019	Associations of MM with outcome	Australia	Australasia	Care homes	Only older people	NA	Quan's CCI	Weighted index	Medical records and administrative database	12	Yes
[129] Chen et al. (2010)	2010	Associations of MM with outcome	Taiwan	Asia	Care homes	Only older people	NA	CCI	Weighted index	Medical records and administrative database	17	Yes
[130] Cheng et al. (2020)	2020	Study of people with MM	China	Asia	Hospitals	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[131] Chin et al. (2016)	2016	Associations of MM with outcome	Hong Kong	Asia	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[132] Clark et al. (2018)	2018	Trajectory of MM	USA	North America	Hospitals	All adults	NA	Deyo CCI	Weighted index	Medical records and administrative database	17	Yes
[133] Collins et al. (2018)	2018	Associations of MM with outcome	USA	North America	Community	Only older people	3+	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[134] Contant et al. (2019)	2019	Study of people with MM	Canada	North America	Primary care	All adults	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	8	Yes
[135] Corrao et al. (2017)	2017	Examination of MM measures	Italy	Europe	Community	All adults	NA	Weighted MCS (multisource comorbidity score)	Weighted index	Medical records and administrative database	46	Yes
[136] Formiga et al. (2016)	2016	Associations of MM with outcome	Spain	Europe	Community	Only older people	NA	CCI	Weighted index	Self-report	19	Yes
[137] Fortin et al. (2006)	2006	Associations of MM with outcome	Canada	North America	Primary care	All adults	NA	CIRS-G	Weighted index	Medical records and administrative database	14	No
[138] Agrawal et al. (2016)	2016	Associations of risk factors with MM	India, China, Russia, Mexico, South Africa, Ghana	Multiple continents	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[139] Fortin et al. (2007)	2007	Patterns of MM	Canada	North America	Primary care	All adults	2+	CIRS-G	Weighted index	Medical records and administrative database	14	Yes
[140] Gorup et al. (2017)	2017	Associations of MM with outcome	Slovenia	Europe	Primary care	Only older people	NA	CIRS-G	Weighted index	Medical records and administrative database	14	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[141] Griffith et al. (2018)	2018	Associations of MM with outcome	UK	Europe	Community	All adults	NA	Functional Comorbidity index	Simple counts of diseases	Self-report	18	Yes
[142] Gu et al. (2018)	2018	Associations of MM with outcome	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[143] Guido et al. (2014)	2014	Associations of MM with outcome	Italy	Europe	Hospitals	Only older people	NA	CIRS-G	Weighted index	Medical records and administrative database	14	Yes
[144] Gunn et al. (2012)	2012	Associations of MM with outcome	Australia	Australasia	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[145] Han et al. (2013)	2013	Associations of MM with outcome	USA	North America	Primary care	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	18	Yes
[146] Hanlon et al. (2018)	2018	Patterns of MM	UK	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	42	Yes
[147] Incalzi et al. (1997)	1997	Associations of MM with outcome	Italy	Europe	Hospitals	Only older people	NA	Index of comorbidity, Index of age-adjusted comorbidity	Weighted index	Medical records and administrative database	33	Yes
[148] Jansa et al. (2010)	2010	Associations of MM with outcome	Spain	Europe	Hospitals	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[149] Jantsch et al. (2018)	2018	Associations of risk factors with MM	Brazil	South America	Community	All adults but not older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[150] John et al. (2003)	2003	Patterns of MM	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[151] Johnson-Lawrence et al. (2017)	2017	Associations of risk factors with MM	USA	North America	Community	All adults but not older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[152] Johnston et al. (2019)	2019	Associations of risk factors with MM	UK	Europe	Community	All adults but not older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[153] Jones et al. (2016)	2016	Examination of MM measures	USA	North America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[154] Jovic et al. (2016)	2016	Associations of risk factors with MM	Serbia	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[155] Jovic et al. (2016)	2016	Patterns of MM	Serbia	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[156] Juul-Larsen et al. (2020)	2020	Patterns of MM	Denmark	Europe	Hospitals	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	34	Yes
[157] Hudon et al. (2008)	2008	Associations of risk factors with MM	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	25	Yes
[158] Hussain et al. (2015)	2015	Patterns of MM	Indonesia	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[159] Hussin et al. (2019)	2019	Associations of risk factors with MM	Malaysia	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[160] Hutchinson et al. (2015)	2015	Associations of MM with outcome	Australia	Australasia	Hospitals	All adults	NA	Quan's CCI	Weighted index	Medical records and administrative database	17	Yes
[161] Ie et al. (2017)	2017	Patterns of MM	USA	North America	Hospitals	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	24	Yes
[162] Ishizaki et al. (2019)	2019	Associations of MM with outcome	Japan	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[163] Jackson et al. (2015)	2015	Trajectory of MM	Australia	Australasia	Community	Only middle-aged	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	18	Yes
[164] Jacobi et al. (2004)	2004	Patterns of MM	Germany	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[165] Januel et al. (2011)	2011	Examination of MM measures	Switzerland	Europe	Hospitals	All adults	NA	CCI and Elixhauser Comorbidity Index	Weighted index	Medical records and administrative database	36	Yes
[166] Danon-Hersch et al. (2012)	2012	Associations of MM with outcome	Switzerland	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[167] de Heer et al. (2013)	2013	Associations of risk factors with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	19	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[168] de Souto Barreto et al. (2014)	2014	Associations of MM with outcome	France	Europe	Care homes	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[169] Demirchyan et al. (2013)	2013	Associations of risk factors with MM	Armenia	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[170] Fabbri et al. (2015)	2015	Associations of risk factors with MM	Italy	Europe	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[171] Fabbri et al. (2016)	2016	Associations of MM with outcome	USA	North America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[172] Farley et al. (2006)	2006	Examination of MM measures	USA	North America	Hospitals	All adults	NA	CCI, Elixhauser, RxRisk	Weighted index	Medical records and administrative database	NA	NA
[173] Feng et al. (2018)	2018	Associations of MM with outcome	USA	North America	Community	All adults but not older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	20	Yes
[174] Fergusson et al. (1993)	1993	Patterns of MM	Zew Zealand	Australasia	Community	Only children	NA	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[175] Ferreira Agreli et al (2017)	2017	Associations of MM with outcome	Brazil	South America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	25	Yes
[176] Fillenbaum et al. (2000)	2000	Associations of MM with outcome	USA	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[177] Finney Rutten et al. (2016)	2016	Associations of MM with outcome	USA	North America	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[178] Ford et al. (2019)	2019	Study of people with MM	UK	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[179] Kadam et al. (2007)	2007	Associations of MM with outcome	UK	Europe	Primary care	Middle aged and older	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	185	No
[180] Kaneko et al. (2019)	2019	Associations of risk factors with MM	Japan	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[181] Kang et al. (2017)	2017	Associations of risk factors with MM	South Korea	Asia	Primary care	All adults but not older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	14	Yes
[182] Gruneir et al. (2016)	2016	Associations of MM with outcome	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	16	Yes
[183] Gandhi et al. (2020)	2020	Associations of MM with outcome	USA	North America	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[184] Corrao et al. (2019)	2019	Patterns of MM	Italy	Europe	Hospitals	Only older people	NA	CIRS-G	Weighted index	Medical records and administrative database	14	Yes
[185] Corrao et al.(2020)	2020	Examination of MM measures	Italy	Europe	Hospitals	Only older people	NA	CIRS-G	Weighted index	Medical records and administrative database	14	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[186] Cortaredona et al.(2017)	2017	Examination of MM measures	France	Europe	Community	All adults	Index score	ICC and PBDI	Weighted index	Medical records and administrative database	22	Yes
[187] Costa et al. (2018)	2018	Patterns of MM	Brazil	South America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	29	Yes
[188] Cramm et al. (2018)	2018	Study of people with MM	the Netherlands	Europe	Primary care	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[189] Crooks et al. (2016)	2016	Examination of MM measures	UK	Europe	Primary care and hospitals	All adults	NA	Elixhauser, CCI, linked score (read code and ICD-10)	Weighted index	Medical records and administrative database	Unclear	NA
[190] Crooks et al. (2015)	2015	Examination of MM measures	UK	Europe	Primary care and hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[191] Dankel et al. (2018)	2018	Associations of risk factors with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[192] Dankel et al. (2017)	2017	Associations of MM with outcome	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[193] Dattalo et al. (2017)	2017	Examination of MM measures	USA	North America	Community	Only older people	2+	Charlson Comorbidity Index (CCI), Medicare's CCW condition categories, Medicare Advantage c-SNP conditions, and the Johns Hopkins ACG®	Weighted index	Medical records and administrative database	NA	NA

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
								Case-Mix System EDCs				
[194] de Carvalho et al. (2018)	2018	Patterns of MM	Brazil	South America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[195] de Souza Leal Neto et al.(2016)	2016	Associations of risk factors with MM	Brazil	South America	Community	Only older people	3+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[196] Verghese et al. (2016)	2016	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	Uncl ear	No
[197] Der-Martirosian et al. (2013)	2013	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Seattle Index of Comorbidity	Weighted index	Self-report	7	Yes
[198] Rizzuto et al. (2017)	2017	Associations of MM with outcome	Sweden	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	36	Yes
[199] Rivera-Almaraz et al. (2018)	2018	Patterns of MM	Mexico	South America	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[200] Schneider et al. (2012)	2012	Examination of MM measures	Switzerland	Europe	Hospitals	All adults	2+	Deyo CCI	Weighted index	Medical records and administrative database	17	Yes
[201] Schneeweiss et al. (2004)	2004	Examination of MM measures	USA and Canada	North America	Hospitals	Only older people	NA	CDS-1, CDS-2, D'Hoore's CCI, Ghali's CCI, deyo CCI, Romano's CCI	Weighted index	Medical records and administrative database	NA	NA
[202] Sara et al.(2018)	2018	Other	Bangladesh	Asia	Hospitals	Only older people	2+	CIRS-G	Weighted index	Self-report	14	Yes
[203] Dhalwani et al. (2017)	2017	Associations of risk factors with MM	UK	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	18	Yes
[204] Di Bari et al. (2006)	2006	Examination of MM measures	Italy	Europe	Community	Only older people	NA	Disease count, CCI, Geriatric Index of Comorbidity (GIC), Chronic Disease Score	Both simple counts and weighted measure	Self-report	NA	NA
[205] Dias et al. (2015)	2015	Examination of MM measures	Portugal	Europe	Hospitals	Only older people	NA	CCI, CIRS-G, Medication-Based Disease Burden Index (MDBI)	Weighted index	Medical records and self-report	19 (CCI); 14 (CIRS-G); 20 (MDBI)	NA
[206] DiBonaventura et al. (2018) [103]	2018	Associations of risk factors with MM	Germany and Italy	Europe	Community	All adults	NA	CCI	Weighted index	Self-report	19	Yes
[207] Diederichs et al.(2012)	2012	Associations of MM with outcome	Germany	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[208] Diez-Manglano et al.(2015)	2015	Associations of MM with outcome	Spain	Europe	Community	Only older people	2+	Simple count of diseases and CCI	Both simple counts and weighted measure	Self-report	15	Yes
[209] Dong et al. (2013)	2013	Examination of MM measures	Taiwan	Asia	Community	All adults	NA	CDS-the Pharmacy-Based Disease Indicator (PBDI), Deyo CCI	Weighted index	Medical records and administrative database	NA	NA
[210] Donze et al.(2013)	2013	Associations of MM with outcome	USA	North America	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[211] Drewes et al.(2011)	2011	Study of people with MM	The Netherlands	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[212] Droomers et al. (2004)	2004	Other	The Netherlands	Europe	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	24	No
[213] Eakin et al. (2007)	2007	Study of people with MM	USA	North America	Primary care	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[214] Sangha et al. (2003)	2003	Examination of MM measures	USA	North America	Hospitals	Middle aged and older	NA	Self-administered comorbidity questionnaire, CCI	Weighted index	Self-report	13	Yes
[215] Salman et al. (2019)	2019	Study of people with MM	UK	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[216] Salisbury et al. (2018)	2018	Study of people with MM	UK	Europe	Primary care	All adults	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	17	No

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[217] Rius et al. (2008)	2008	Examination of MM measures	Spain	Europe	Community	Middle aged and older	NA	Rius's comorbidity index	Weighted index	Self-report	16	Yes
[218] Elixhauser et al. (1998)	1998	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Elixhauser's Comorbidity Index	Weighted index	Medical records and administrative database	30	Yes
[219] Eton et al. (2017)	2017	Study of people with MM	USA	North America	Hospitals	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[220] Fabbri et al. (2015)	2015	Associations of risk factors with MM	USA	North America	Hospitals	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[221] Feng et al. (2018)	2018	Associations of MM with outcome	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	19	Yes
[222] Ferrer et al. (2017)	2017	Patterns of MM	Spain	Europe	Primary care	Only older people	MCC	Simple count of diseases and CCI	Both simple counts and weighted measure	Medical records and administrative database	16	Yes
[223] Ferro et al. (2019)	2019	Associations of MM with outcome	Canada	North America	Primary care	Only children	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[224] Foguet-Boreu et al. (2015)	2015	Study of people with MM	Spain	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[225] Fortin et al.(2006)	2006	Associations of MM with outcome	Canada	North America	Primary care	All adults	MCC	Simple count of diseases and CIRS-G	Both simple counts and weighted measure	Medical records and administrative database	14	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[226] Fortin et al.(2005)	2005	Other	Canada	North America	Primary care	All adults	2+	Simple count of diseases and CIRS-G	Both simple counts and weighted measure	Medical records and administrative database	14	Yes
[227] Fortin et al.(2014)	2014	Associations of risk factors with MM	Canada	North America	Community	Middle aged and older	3+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[228] Fortin et al. (2005)	2005	Examination of MM measures	Canada	North America	Primary care	All adults	MCC	CIRS-G, CCI, Fuctional Comorbidity Index	Weighted index	Medical records and administrative database	14 (CIRS), FCI (18), CCI (19)	NA
[229] Fortin et al. (2010)	2010	Examination of MM measures	Canada	North America	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and self-report	7	Yes
[230] Fortin et al. (2017)	2017	Examination of MM measures	Canada	North America	Hospitals	All adults	NA	Elixhauser comorbidity measure and Quan's CCI	Weighted index	Medical records and administrative database	NA	NA
[231] Fraccaro et al. (2016)	2016	Trajectory of MM	UK	Europe	Primary care	All adults	NA	Khan's CCI	Weighted index	Medical records and administrative database	15	Yes
[232] Fuchs et al. (1998)	1998	Associations of MM with outcome	Israel	Asia	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[233] Fung et al. (2008)	2008	Associations of MM with outcome	USA	North America	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[234] Gadermann et al. (2012)	2012	Other	Spain	Europe	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	19	Yes
[235] Gagne et al. (2011)	2011	Examination of MM measures	USA	North America	Community	Only older people	NA	Romano's CCI, Elixhauser Comorbidity Index, combination of both measures	Weighted index	Medical records and administrative database	NA	NA
[236] Galenkamp et al. (2011)	2011	Associations of MM with outcome	the Netherlands	Europe	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[237] Galenkamp et al. (2016)	2016	Study of people with MM	Germany, UK, Italy, The Netherlands, Spain and Sweden	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[238] Gallegos-Carrillo et al.(2009)	2009	Study of people with MM	Mexico	South America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[239] Gallo et al.(2016)	2016	Study of people with MM	USA	North America	Community	Only older people	NA	CCI	Weighted index	Self-report	19	Yes
[240] Gamma et al. (2001)	2001	Associations of MM with outcome	Switzerland	Europe	Community	All adults but not older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[241] Gaulin et al.(2019)	2019	Associations of MM with outcome	Canada	North America	Hospitals	All adults	MCC	Simple count of diseases and CCI	Both simple counts and weighted measure	Medical records and administrative database	34	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[242] Gawron et al.(2020)	2020	Associations of MM with outcome	USA	North America	Hospitals	All adults but not older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[243] Ge et al. (2018)	2018	Associations of MM with outcome	Singapore	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes
[244] Ge et al. (2019)	2019	Associations of MM with outcome	Singapore	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes
[245] Gibbons et al. (2013)	2013	Study of people with MM	UK	Europe	Primary care	Only older people	2+	Simple count of diseases and Bayliss's comorbidity burden measure	Both simple counts and weighted measure	Medical records and administrative database	5	Yes
[246] Gili et al. (2010)	2010	Associations of MM with outcome	Spain	Europe	Primary care	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[247] Gnadinger et al. (2018)	2018	Other	Switzerland	Europe	Primary care	All adults	3+	Thurgau Morbidity Index	Weighted index	Medical records and administrative database	Unclear	No
[248] Excoffier et al.(2018)	2018	Other	Switzerland	Europe	Primary care	All adults	MCC	N'Goran's measure	Simple counts of diseases	Medical records and administrative database	75	Yes
[249] Turner Goins et al.(2019)	2019	Associations of risk factors with MM	USA	North America	Community	Middle aged and older	NA	Goins's index	Simple counts of diseases	Self-report	32	Yes
[250] Gould et al.(2016)	2016	Associations of MM with outcome	USA	North America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[251] Griffith et al.(2019)	2019	Examination of MM measures	Canada	North America	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	31	Yes
[252] Habib et al.(2014)	2014	Associations of risk factors with MM	Lebanon	Asia	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[253] Harris et al.(2016)	2016	Study of people with MM	USA	North America	Community	All adults	2+	Simple count of diseases and CCI	Both simple counts and weighted measure	Medical records and administrative database	5	Yes
[254] Harrison et al.(2017)	2017	Patterns of MM	Australia	Australasia	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	28	No
[255] Harrison et al.(2012)	2012	Study of people with MM	UK	Europe	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	23	No
[256] Hayek et al.(2017)	2017	Patterns of MM	Israel	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[257] Heller et al.(2009)	2009	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Deyo CCI	Weighted index	Self-report	23	Yes
[258] Helvik et al.(2013)	2013	Associations of MM with outcome	Norway	Europe	Hospitals	Only older people	NA	Quan's CCI (2005)	Weighted index	Medical records and administrative database	17	Yes
[259] Henninger et al.(2012)	2012	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[260] Hernandez et al.(2019)	2019	Patterns of MM	Ireland	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	31	Yes
[261] Hillen et al.(2017)	2017	Patterns of MM	Australia	Australasia	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[262] Ho et al.(2014)	2014	Associations of MM with outcome	Singapore	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[263] Holman et al.(2005)	2005	Examination of MM measures	Australia	Australasia	Hospitals	All adults	Index score	A Multipurpose Australian Comorbidity Scoring System	Weighted index	Medical records and administrative database	102	Yes
[264] Hopman et al.(2016)	2016	Study of people with MM	the Netherlands	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[265] Hu et al.(2019)	2019	Patterns of MM	Taiwan	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	20	Yes
[266] Huang et al.(2019)	2019	Study of people with MM	USA	North America	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	13	Yes
[267] Hudon et al.(2012)	2012	Associations of MM with outcome	Canada	North America	Primary care	All adults	2+	Disease Burden Morbidity Assessment	Weighted index	Self-report	11	Yes
[268] Katikireddi et al.(2017)	2017	Associations of risk factors with MM	UK	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	40	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[269] Kenning et al.(2015)	2015	Study of people with MM	UK	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	21	Yes
[270] Khan et al.(2010)	2010	Examination of MM measures	UK	Europe	Primary care	Middle aged and older	NA	Deyo CCI	Weighted index	Medical records and administrative database	17	Yes
[271] Khan et al.(2019)	2019	Associations of risk factors with MM	Bangladesh	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[272] Ki et al. (2017)	2017	Associations of risk factors with MM	South Korea	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	66	Yes
[273] Kil et al. (2012)	2012	Examination of MM measures	South Korea	Asia	Hospitals	Middle aged and older	NA	Asan Comorbidity Index	Weighted index	Medical records and administrative database	70	Yes
[274] Kilgore et al. (2012)	2012	Examination of MM measures	USA	North America	Community	Only older people	NA	CCI	Weighted index	Medical records and administrative database	17	Yes
[275] Kiliari et al. (2013)	2013	Other	Cyprus	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[276] Kim et al. (2012)	2012	Associations of MM with outcome	South Korea	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[277] Kim et al. (2018)	2018	Associations of MM with outcome	South Korea	Asia	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	34	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[278] Kim et al. (2018)	2018	Associations of MM with outcome	Ireland	Europe	Primary care	Middle aged and older	MCC	RxRisk-V	Weighted index	Self-report	27	Yes
[279] King et al.(2018)	2018	Trajectory of MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[280] Kingston et al. (2018)	2018	Trajectory of MM	UK	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[281] Koyanagi et al.(2018)	2018	Associations of MM with outcome	China, Ghana, India, Mexico, Russia, and South Africa	Multiple continents	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[282] Kriegsman et al. (2004)	2004	Associations of MM with outcome	the Netherlands	Europe	Community	Middle aged and older	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[283] Kristensen et al. (2019)	2019	Associations of MM with outcome	Germany	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[284] Kristensen et al. (2019)	2019	Associations of MM with outcome	Germany	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[285] Kumar et al. (2016)	2016	Examination of MM measures	USA	North America	Community	Only older people	NA	CCI, Elixhauser, FCI, HCC, Tier Comorbidity	Weighted index	Medical records and administrative database	NA	NA
[286] Kunna et al. (2017)	2017	Study of people with MM	China, Ghana	Multiple continents	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[287] Kusumastuti et al. (2017)	2017	Associations of MM with outcome	Muti-nations	Multiple continents	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[288] Kuwornu et al. (2014)	2014	Patterns of MM	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[289] Lai et al. (2019)	2019	Associations of risk factors with MM	Hong Kong	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[290] Lai et al. (2018)	2018	Associations of MM with outcome	Hong Kong	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[291] Laires et al. (2019)	2019	Associations of MM with outcome	Portugal	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[292] Landi et al. (2016)	2016	Associations of MM with outcome	Italy	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[293] Landi et al. (2010)	2010	Associations of MM with outcome	Italy	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[294] Lang et al. (2015)	2015	Associations of MM with outcome	USA	North America	Community	Only middle-aged	2+	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[295] Langsted et al. (2020)	2020	Associations of MM with outcome	Denmark	Europe	Hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	19	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[296] Laux et al. (2008)	2008	Associations of MM with outcome	Germany	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[297] Lawson et al. (2013)	2013	Associations of MM with outcome	UK	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	40	Yes
[298] Le Cossec et al. (2016)	2016	Associations of risk factors with MM	France	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	4	Yes
[299] Lee et al. (2020)	2020	Study of people with MM	South Korea	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[300] Lee et al. (2016)	2016	Study of people with MM	USA	North America	Primary care	Only older people	2+	CCI	Weighted index	Self-report	19	Yes
[301] Lee et al. (2007)	2007	Patterns of MM	USA	North America	Hospitals	Only middle-aged	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	11	Yes
[302] Lee et al. (2018)	2018	Associations of MM with outcome	Taiwan	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[303] Lenzi et al. (2016)	2016	Associations of risk factors with MM	Italy	Europe	Hospitals	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	26	Yes
[304] LePage et al. (2014)	2014	Associations of MM with outcome	USA	North America	Primary care	All adults	NA	CCI	Weighted index	Medical records and administrative database	19	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[305] Li et al. (2016)	2016	Associations of MM with outcome	UK	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[306] Li et al. (2019)	2019	Study of people with MM	USA	North America	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[307] Librero et al. (1999)	1999	Associations of MM with outcome	Spain	Europe	Hospitals	All adults	NA	Librero's CCI	Weighted index	Medical records and administrative database	17	Yes
[308] Liu-Ambrose et al. (2010)	2010	Study of people with MM	Canada	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[309] Lobo-Escolar et al. (2008)	2008	Associations of MM with outcome	Spain	Europe	Community	Middle aged and older	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[310] Loprinzi (2015)	2015	Associations of risk factors with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[311] Loprinzi (2017)	2017	Associations of risk factors with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[312] Lorem et al. (2016)	2016	Examination of MM measures	Norway	Europe	Community	All adults	NA	CCI and health impact index	Weighted index	Self-report	28	Yes
[313] Low et al. (2019)	2019	Associations of risk factors with MM	Singapore	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	48	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[314] Lu et al. (2011)	2011	Examination of MM measures	Australia	Australasia	Hospitals	Only older people	NA	CCI and Rx-Risk	Weighted index	Medical records and administrative database	NA	NA
[315] Lujic et al. (2017)	2017	Examination of MM measures	Australia	Australasia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[316] Lupianez-Villanueva et al.(2018)	2018	Associations of MM with outcome	14 European countries	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[317] Zhou et al. (2018)	2018	Associations of MM with outcome	Bangladesh, India and China	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[318] Zhang et al. (2019)	2019	Patterns of MM	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[319] Yamada et al. (2015) [148]	2015	Associations of MM with outcome	Czech Republic	Europe	Care homes	Middle aged and older	NA	CCI	Weighted index	Medical records and administrative database	17	Yes
[320] Wong et al. (2010)	2010	Associations of MM with outcome	Canada	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[321] White (2018)	2018	Study of people with MM	USA	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	20	Yes
[322] Weimann et al. (2016)	2016	Trajectory of MM	South Africa	Africa	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	4	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[323] Wei et al. (2019)	2019	Associations of MM with outcome	USA	North America	Community	All adults	NA	Multimorbidity weighted index	Weighted index	Self-report	81	Yes
[324] Wang et al. (2017)	2017	Examination of MM measures	Australia	Australasia	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[325] Wang et al. (2017)	2017	Associations of MM with outcome	USA	North America	Hospitals	All adults	NA	Elixhauser's Comorbidity Index	Weighted index	Medical records and administrative database	30	Yes
[326] Wang et al. (2007)	2007	Associations of MM with outcome	Taiwan	Asia	Hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[327] Wang et al. (2019)	2019	Associations of MM with outcome	South Africa	Africa	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[328] Walker et al. (2007)	2007	Associations of MM with outcome	Australia	Australasia	Community	All adults	3+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[329] Wade et al. (2019)	2019	Associations of MM with outcome	New Zealand	Australasia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[330] Maciejewski et al. (2019)	2019	Associations of MM with outcome	USA	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	19	Yes
[331] MacKnight et al. (2001)	2001	Associations of risk factors with MM	Canada	North America	Community	Only older people	NA	CDS	Weighted index	Medical records and administrative database	23	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[332] Marengoni et al. (2016)	2016	Patterns of MM	Sweden	Europe	Community	Only older people	2+	CIRS-G	Weighted index	Self-report	14	Yes
[333] Marengoni et al. (2009)	2009	Patterns of MM	Sweden	Europe	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[334] Déruaz-Luyet et al. (2017)	2017	Patterns of MM	Switzerland	Europe	Primary care	All adults	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	75	Yes
[335] Marengoni et al. (2009)	2009	Associations of MM with outcome	Sweden	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	22	Yes
[336] Marques et al. (2018)	2018	Associations of risk factors with MM	13 European countries	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[337] Martin-Garcia et al. (2013)	2013	Associations of MM with outcome	Spain	Europe	Care homes	Only older people	MCC	CIRS-G	Weighted index	Medical records and administrative database	20	No
[338] Martinez-Velilla et al. (2014)	2014	Examination of MM measures	Spain	Europe	Hospitals	Only older people	NA	CIRS-G, CCI, Index of Coexistent Disease, disease counts, Geriatric index of comorbidity	Both simple counts and weighted measure	Medical records and administrative database	NA	NA
[339] Mavaddat et al. (2014)	2014	Associations of MM with outcome	UK	Europe	Primary care	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[340] Mazzella et al. (2010)	2010	Associations of MM with outcome	Italy	Europe	Primary care	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[341] McDaid et al. (2013)	2013	Associations of MM with outcome	Ireland	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[342] Md Yusof et al. (2010)	2010	Examination of MM measures	UK	Europe	Community	Only older people	NA	CCI, Md Yusof's comorbidity index	Weighted index	Self-report	NA	NA
[343] Melis et al. (2014)	2014	Trajectory of MM	Sweden	Europe	Hospitals	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	39	Yes
[344] Mercer et al. (2016) [161]	2016	Study of people with MM	UK	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[345] Min et al. (2007)	2007	Associations of MM with outcome	USA	North America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[346] Min et al. (2014)	2014	Associations of MM with outcome	USA	North America	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	12	Yes
[347] Mnatzaganian et al. (2012)	2012	Examination of MM measures	Australia	Australasia	Hospitals	Only older people	NA	Deyo CCI, Enhanced-Charlson Index, and Elixhauser's method	Weighted index	Medical records and administrative database	NA	NA
[348] Mokraoui et al. (2016)	2016	Examination of MM measures	Canada	North America	Primary care	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	21	Yes
[349] Momtaz et al. (2010)	2010	Associations of MM with outcome	Malaysia	Asia	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[350] Mondor et al. (2018)	2018	Trajectory of MM	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	17	Yes
[351] Mondor et al. (2016)	2016	Associations of MM with outcome	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	16	Yes
[352] Montes et al. (2020)	2020	Associations of MM with outcome	Brazil	South America	Community	Only older people	5+	Simple counts of diseases	Simple counts of diseases	Self-report	28	Yes
[353] Moore et al. (2014)	2014	Patterns of MM	USA	North America	Care homes	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	20	Yes
[354] Mori et al. (2019)	2019	Associations of MM with outcome	Japan	Asia	Community	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[355] Mortsiefer et al (2017) [162]	2017	Study of people with MM	Germany	Europe	Community	Only older people	NA	Unclear	Unclear	NA	Unclear	No
[356] Mueller-Schotte et al. (2020)	2020	Associations of MM with outcome	the Netherlands	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes
[357] Muggah et al. (2012)	2012	Associations of MM with outcome	Canada	North America	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	9	Yes
[358] Mukherjee et al. (2011)	2011	Examination of MM measures	USA	North America	Community	All adults	NA	Health-related quality of life comorbidity index	Weighted index	Medical records and administrative database	44	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[359] Nagel et al. (2017)	2017	Associations of MM with outcome	Germany	Europe	Community	Only older people	3+	Simple counts of diseases	Simple counts of diseases	Self-report	21	Yes
[360] Nagel et al. (2008)	2008	Associations of risk factors with MM	Germany	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[361] Nagl et al. (2012)	2012	Associations of MM with outcome	Germany	Europe	Primary care	Only older people	2+	Cumulative multimorbidity score based on 33 patient-reported diseases	Weighted index	Medical records and administrative database	33	No
[362] Naithani et al. (2010)	2010	Associations of MM with outcome	UK	Europe	Hospitals	All adults	NA	CIRS-G	Weighted index	Medical records and administrative database	14	Yes
[363] Narayan et al. (2017)	2017	Examination of MM measures	New Zealand	Australasia	Community	Only older people	NA	Medicines Comorbidity Index	Weighted index	Medical records and administrative database	20	Yes
[364] New et al. (2017)	2017	Examination of MM measures	Australia	Australasia	Hospitals	All adults	NA	CCI and CIRS-G	Weighted index	Medical records and administrative database	NA	NA
[365] Nguyen et al. (2019)	2019	Associations of risk factors with MM	Canada	North America	Community	All adults	3+	Simple counts of diseases	Simple counts of diseases	Self-report	19	Yes
[366] Niedzwiedz et al. (2019)	2019	Associations of risk factors with MM	USA	North America	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[367] Nilssen et al. (2014)	2014	Examination of MM measures	Norway	Europe	Primary care	Whole population	MCC	CCI with Patient Register Index [PRI] weights	Weighted index	Medical records and administrative database	17	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[368] Nobrega et al. (2009)	2009	Associations of MM with outcome	Brazil	South America	Primary care	Only older people	NA	CIRS-G	Weighted index	Medical records and administrative database	13	Yes
[369] Nunes et al. (2016)	2016	Patterns of MM	Brazil	South America	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[370] Nunes et al. (2017)	2017	Associations of risk factors with MM	Brazil	South America	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	22	Yes
[371] Nunes et al.(2015)	2015	Other	Brazil	South America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes
[372] Nutzel et al.(2014)	2014	Patterns of MM	Germany	Europe	Primary care	Only older people	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	29	Yes
[373] Olaya et al.(2017)	2017	Associations of MM with outcome	Spain	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[374] Olaya et al.(2017)	2017	Patterns of MM	Spain	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[375] Olivares et al.(2017)	2017	Associations of risk factors with MM	Argentina	South America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[376] Olsson et al.(2005)	2005	Associations of MM with outcome	Sweden	Europe	Hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	17	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[377] Ou et al.(2016)	2016	Examination of MM measures	USA	North America	Community	All adults	NA	Refined HRQoL-CI	Weighted index	Medical records and administrative database	25	Yes
[378] Pache et al.(2015)	2015	Examination of MM measures	Switzerland	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	38	Yes
[379] Paddison et al.(2015)	2015	Study of people with MM	UK	Europe	Primary care	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	16	No
[380] Park et al. (2018)	2018	Associations of MM with outcome	South Korea	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	25	Yes
[381] Park et al. (2014)	2014	Study of people with MM	South Korea	Asia	Care homes	Middle aged and older	2+	Unclear	Unclear	NA	Unclear	No
[382] Parker et al.(2003)	2003	Examination of MM measures	USA	North America	Hospitals	All adults	NA	CDS and Deyo CCI	Weighted index	Medical records and administrative database	NA	NA
[383] Parkerson et al.(1993)	1993	Examination of MM measures	USA	North America	Primary care	All adults	NA	Duke Severity of Illness Checklist	Weighted index	Medical records and administrative database	21	Yes
[384] Patel et al.(2006)	2006	Associations of MM with outcome	Mexico	South America	Community	Middle aged and older	NA	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[385] Pati et al.(2016)	2016	Examination of MM measures	India	Asia	Community	All adults	2+	Multimorbidity Assessment Questionnaire for Primary Care	Weighted index	Self-report	18	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[386] Pati et al.(2019)	2019	Associations of MM with outcome	India	Asia	Primary care	All adults	2+	Multimorbidity Assessment Questionnaire for Primary Care (	Simple counts of diseases	Self-report	21	Yes
[387] Pati et al.(2017)	2017	Patterns of MM	India	Asia	Primary care	All adults	2+	Multimorbidity Assessment Questionnaire for Primary Care	Simple counts of diseases	Self-report	21	Yes
[388] Patrick et al.(2001)	2001	Associations of MM with outcome	Canada	North America	Hospitals	Only older people	NA	CIRS-G	Weighted index	Medical records and administrative database	14	Yes
[389] Payne et al.(2013)	2013	Associations of MM with outcome	UK	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	40	Yes
[390] Peng et al.(2014)	2014	Associations of MM with outcome	Taiwan	Asia	Hospitals	Only older people	NA	CCI	Weighted index	Self-report	19	Yes
[391] Peng et al.(2020)	2020	Associations of MM with outcome	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[392] Perez et al.(2020)	2020	Trajectory of MM	Sweden	Europe	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	60	Yes
[393] Perkins et al.(2004)	2004	Examination of MM measures	USA	North America	Primary care	Only older people	NA	ACG, Medication-based index, CCI, CDS	Weighted index	Medical records and administrative database	NA	NA
[394] Pessini et al. (2016)	2016	Associations of MM with outcome	Brazil	South America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[395] Petersen et al.(2019)	2019	Associations of risk factors with MM	South Africa	Africa	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	Unclear	No
[396] Pfortmueller et al.(2013)	2013	Other	Switzerland	Europe	Hospitals	All adults	NA	Simple count of diseases and CCI	Both simple counts and weighted measure	Medical records and administrative database	18	Yes
[397] Poitras et al.(2012)	2012	Examination of MM measures	France	Europe	Primary care	All adults	NA	DBMA (French-version)	Weighted index	Self-report	21	Yes
[398] Portz et al.(2017)	2017	Associations of MM with outcome	USA	North America	Hospitals	Only older people	Index score	D'Hoor's CCI	Weighted index	Self-report	19	Yes
[399] Pratt et al.(2018)	2018	Examination of MM measures	Australia	Australasia	Hospitals	Only older people	NA	Rx-Risk	Weighted index	Medical records and administrative database	46	Yes
[400] Prazeres et al.(2015)	2015	Patterns of MM	Portugal	Europe	Primary care	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[401] Prazeres et al.(2018)	2018	Examination of MM measures	Portugal	Europe	Primary care	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	147 and 75	NA
[402] Pressley et al.(1999)	1999	Associations of MM with outcome	USA	North America	Hospitals	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[403] Prior et al. (2016)	2016	Study of people with MM	Denmark	Europe	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	39	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[404] Prior et al.(2018)	2018	Study of people with MM	Denmark	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	39	Yes
[405] Pruchno et al.(2016)	2016	Associations of MM with outcome	USA	North America	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[406] Pylvalainen et al.(2019)	2019	Examination of MM measures	Finland	Europe	Community	Middle aged and older	NA	Deyo CCI, Quan's CCI, medication-based CCI	Weighted index	Self-report	NA	NA
[407] Quah et al.(2017)	2017	Associations of MM with outcome	Singapore	Asia	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	14	Yes
[408] Quail et al.(2011)	2011	Examination of MM measures	Canada	North America	Hospitals	All adults	NA	Coutns of diagnosis, CCI, Elixhauser's CCI, CDS	Both simple counts and weighted measure	Medical records and administrative database	NA	NA
[409] Quan et al. (2011)	2011	Examination of MM measures	Canada	North America	Hospitals	All adults	NA	Quan's CCI (12 conditions) and CCI (17 conditions)	Weighted index	Medical records and administrative database	12	Yes
[410] Quan et al. (2002)	2002	Examination of MM measures	Canada	North America	Hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	17	Yes
[411] Quan et al. (2005)	2005	Examination of MM measures	Canada	North America	Hospitals	All adults	NA	CCI and Elixauser's CCI	Weighted index	Medical records and administrative database	NA	NA
[412] Quinones et al.(2019)	2019	Trajectory of MM	USA	North America	Community	Only middle-aged	2+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[413] Quinones et al.(2016)	2016	Patterns of MM	USA	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[414] Quinones et al.(2018)	2018	Associations of MM with outcome	USA	North America	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[415] Quinones et al.(2011)	2011	Trajectory of MM	USA	North America	Community	Middle aged and older	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[416] Rafiq et al.(2019)	2019	Associations of MM with outcome	Sweden	Europe	Hospitals	Middle aged and older	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[417] Ramiarina et al.(2008)	2008	Examination of MM measures	Brazil	South America	Hospitals	All adults	NA	Ramiarina's CCI	Weighted index	Medical records and administrative database	17	Yes
[418] Ramond-Roquin et al.(2016)	2016	Examination of MM measures	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	21	Yes
[419] Randall et al.(2018)	2018	Associations of MM with outcome	Australia	Australasia	Community	Whole population	2+	Simple counts of diseases	Simple counts of diseases	Self-report	30	Yes
[420] Ranstad et al.(2017)	2017	Associations of MM with outcome	Sweden	Europe	Primary care	All adults	NA	ACG system	Weighted index	Medical records and administrative database	Unclear	No
[421] Ranstad et al.(2014)	2014	Associations of MM with outcome	Sweden	Europe	Primary care	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[422] Rast et al.(2014)	2014	Associations of MM with outcome	USA	North America	Community	Middle aged and older	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[423] Reinke et al.(2019)	2019	Study of people with MM	USA	North America	Primary care	All adults	NA	Elixhauser's CCI	Weighted index	Medical records and administrative database	30	Yes
[424] Ribeiro et al.(2018)	2018	Associations of risk factors with MM	Brazil	South America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[425] Rose et al. (2018)	2018	Study of people with MM	USA	North America	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[426] Roso-Llorach et al.(2018)	2018	Patterns of MM	Spain	Europe	Primary care	Only middle-aged	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[427] Rozzini et al.(2002)	2002	Examination of MM measures	Italy	Europe	Hospitals	Only older people	NA	Geriatric index of comorbidity, number of diseases and disease burden	Weighted index	Medical records and administrative database	15	Yes
[428] Ruel et al.(2014)	2014	Trajectory of MM	Australia	Australasia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[429] Ruel et al.(2014)	2014	Trajectory of MM	China	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[430] Russell et al.(2020)	2020	Associations of risk factors with MM	New Zealand	Australasia	Community	Only children	2+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[431] Ryan et al.(2018)	2018	Trajectory of MM	Ireland	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	16	Yes
[432] Sasseville et al.(2019)	2019	Examination of MM measures	Ireland	Europe	Primary care	Only older people	3+	Medication classes count, Chronic disease count Barnett et al.(2012)	Weighted index	Medical records and administrative database	40	Yes
[433] Barnett et al. (2012)	2012	Associations of risk factors with MM	UK	Europe	Primary care	Whole population	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	40	Yes
[434] Schafer et al.(2014)	2014	Patterns of MM	Germany	Europe	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	46	Yes
[435] Schafer et al.(2010)	2010	Patterns of MM	Germany	Europe	Community	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	46	Yes
[436] Schamess et al.(2017)	2017	Study of people with MM	USA	North America	Hospitals	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[437] Schilling et al.(2013)	2013	Associations of MM with outcome	Germany	Europe	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	37	Yes
[438] Schmidt et al.(2016)	2016	Associations of risk factors with MM	Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, and Switzerland	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[439] Schneeweiss et al.(2001)	2001	Examination of MM measures	USA	North America	Community	Only older people	NA	CCI (Romano, D'Hoore, Deyo, Ghali), CDS	Weighted index	Medical records and administrative database	NA	NA
[440] Schneeweiss et al.(2003)	2003	Examination of MM measures	USA	North America	Community	Only older people	NA	CCI (Romano, Elixhauser), CDS	Weighted index	Medical records and administrative database	NA	NA
[441] Schottker et al.(2016)	2016	Associations of risk factors with MM	Germany	Europe	Primary care	Middle aged and older	2+	CIRS-G	Weighted index	Medical records and administrative database	14	Yes
[442] Schuttner et al.(2020)	2020	Study of people with MM	USA	North America	Primary care	All adults	2+	Chronic Condition Indicator	Weighted index	Medical records and administrative database	18	Yes
[443] Schuz et al.(2011)	2011	Study of people with MM	Germany	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	23	No
[444] Schuz et al.(2015)	2015	Study of people with MM	Germany	Europe	Community	Only older people	2+	Conditions informed by CCI or Functional Cormobidity Index	Simple counts of diseases	Self-report	Unclear	No
[445] Schuz et al.(2016)	2016	Study of people with MM	Germany	Europe	Community	Only older people	2+	Conditions informed by CCI or Functional Cormobidity Index	Simple counts of diseases	Self-report	Unclear	No
[446] Schuz et al.(2014)	2014	Study of people with MM	Germany	Europe	Community	Only older people	2+	Conditions informed by CCI or Functional Cormobidity Index	Simple counts of diseases	Self-report	Unclear	No

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[447] Schuz et al.(2012)	2012	Study of people with MM	Germany	Europe	Community	Only older people	2+	Conditions informed by CCI or Functional Cormobidity Index	Simple counts of diseases	Self-report	Unclear	No
[448] Selim et al.(2004)	2004	Examination of MM measures	USA	North America	Primary care	All adults	NA	Comorbidity index (CI)	Weighted index	Self-report	36	Yes
[449] Seo et al.(2017)	2017	Associations of MM with outcome	South Korea	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[450] Seo et al.(2019)	2019	Associations of risk factors with MM	South Korea	Asia	Community	All adults	3+	Simple counts of diseases	Simple counts of diseases	Self-report	46	Yes
[451] van den Bussche et al. (2011)	2011	Patterns of MM	Germany	Europe	Community	Only older people	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	46	Yes
[452] Shakib et al.(2016)	2016	Study of people with MM	Australia	Australasia	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[453] She et al. (2019)	2019	Patterns of MM	China	Asia	Hospitals	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	22	Yes
[454] Shih et al.(2015)	2015	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Elixhauser's CI, Deyo CCI, Medicare comorbidity tier system	Weighted index	Medical records and administrative database	NA	NA
[455] Shih et al.(2016)	2016	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Elixhauser's CI, Deyo CCI, Medicare comorbidity tier system	Weighted index	Medical records and administrative database	NA	NA

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[456] Shwartz et al.(1996)	1996	Examination of MM measures	USA	North America	Hospitals	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	52	Yes
[457] Silay et al.(2017)	2017	Associations of MM with outcome	Turkey	Asia	Care homes	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[458] Singer et al.(2019)	2019	Trajectory of MM	UK	Europe	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	25	Yes
[459] Singh et al.(2019)	2019	Associations of MM with outcome	India	Asia	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[460] Smith et al.(2008)	2008	Study of people with MM	Ireland	Europe	Primary care	Only middle-aged	3+	Unclear	Unclear	NA	Unclear	No
[461] Spangenberg et al.(2011)	2011	Associations of MM with outcome	Germany	Europe	Community	Only older people	5+	Bayliss's measure	Simple counts of diseases	Self-report	25	Yes
[462] St Sauver et al.(2015)	2015	Trajectory of MM	USA	North America	Primary care	Whole population	2+	Goodman's measure	Simple counts of diseases	Medical records and administrative database	20	Yes
[463] Stanley et al.(2017)	2017	Examination of MM measures	New Zealand	Australasia	Hospitals	All adults	NA	M3	Weighted index	Medical records and administrative database	61	Yes
[464] Stanley et al.(2018)	2018	Associations of MM with outcome	New Zealand	Australasia	Hospitals	All adults	2+	M3	Weighted index	Medical records and administrative database	61	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[465] Starfield et al.(2003)	2003	Study of people with MM	USA	North America	Hospitals	All adults	NA	ACG system	Weighted index	Medical records and administrative database	Unclear	No
[466] Steel et al.(2019)	2019	Study of people with MM	UK	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	40	Yes
[467] Steinman et al.(2012)	2012	Patterns of MM	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	23	Yes
[468] Stenholm et al.(2015)	2015	Associations of MM with outcome	Finland	Europe	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[469] Stepanova et al.(2015)	2015	Associations of risk factors with MM	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[470] Stickley et al.(2020)	2020	Associations of MM with outcome	USA	North America	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[471] Stokes et al.(2017)	2017	Study of people with MM	UK	Europe	Hospitals	All adults	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	20	Yes
[472] Streit et al.(2014)	2014	Associations of MM with outcome	Switzerland	Europe	Primary care	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	17	Yes
[473] Strickland et al.(2018)	2018	Study of people with MM	UK	Europe	Primary care	All adults	3+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	8	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[474] Stubbs et al. (2018)	2018	Associations of risk factors with MM	China, Ghana, India, Mexico, Russia, South Africa	Multiple continents	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[475] Stukenborg et al.(2001)	2001	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Deyo CCI, Elixhauser's CI	Weighted index	Medical records and administrative database	NA	NA
[476] Su et al.(2016)	2016	Associations of MM with outcome	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	10	Yes
[477] Subramaniam et al.(2019)	2019	Study of people with MM	Singapore	Asia	Primary care	All adults	2+	Unclear	Unclear	NA	Unclear	No
[478] Sullivan et al.(2012)	2012	Associations of risk factors with MM	USA	North America	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	259	No
[479] Sundararajan et al.(2004)	2004	Examination of MM measures	Australia	Australasia	Hospitals	All adults	NA	Deyo' CCI (ICD-10 and ICD-9)	Weighted index	Medical records and administrative database	17	Yes
[480] Sundararajan et al.(2007)	2007	Examination of MM measures	Australia	Australasia	Hospitals	All adults	NA	Halfon, Sundararajan, and Quan versions	Weighted index	Medical records and administrative database	NA	NA
[481] Sundstrup et al.(2017)	2017	Associations of MM with outcome	USA	North America	Community	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[482] Susser et al.(2008)	2008	Examination of MM measures	Canada	North America	Hospitals	Only older people	NA	CCI based on self-report and administrative data	Weighted index	Self-report and administrative data	18	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[483] Tai et al.(2006)	2006	Examination of MM measures	Canada	North America	Hospitals	Only children	NA	Pediatric comorbidity model	Weighted index	Medical records and administrative database	37 (listed but most are acute conditions)	NA
[484] Takahashi et al.(2016)	2016	Associations of risk factors with MM	USA	North America	Hospitals	All adults	NA	Minnesota Medical Tiering	Weighted index	Medical records and administrative database	Unclear	No
[485] Taleshan et al.(2018)	2018	Patterns of MM	Denmark	Europe	Community	All adults	2+	CCI + 4 psychiatric disorders	Weighted index	Self-report	21	Yes
[486] Tan et al.(2013)	2013	Associations of MM with outcome	Singapore	Asia	Hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[487] Tetzlaff et al.(2017)	2017	Examination of MM measures	Germany	Europe	Community	Only older people	3+	van den Bussche's measure	Weighted index	Medical records and administrative database	46	Yes
[488] Thavorn et al.(2017)	2017	Associations of MM with outcome	Canada	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	16	Yes
[489] Theou et al.(2012)	2012	Associations of MM with outcome	Canada	North America	Community	Only older people	2+	Unclear	Unclear	NA	Unclear	No
[490] Thompson et al.(2015)	2015	Examination of MM measures	USA	North America	Hospitals	All adults	NA	Elixhauser with 30 conditions and 29 conditions	Weighted index	Medical records and administrative database	29	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[491] Thygesen et al.(2011)	2011	Examination of MM measures	Denmark	Europe	Hospitals	All adults	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[492] Tinetti et al.(2011)	2011	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[493] Tinetti et al.(2012)	2012	Associations of MM with outcome	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[494] Tinetti et al.(2015)	2015	Study of people with MM	USA	North America	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	9	Yes
[495] Tinetti et al.(2019)	2019	Study of people with MM	USA	North America	Primary care	Only older people	3+	Unclear	Unclear	NA	Unclear	No
[496] Tooth et al.(2008)	2008	Examination of MM measures	Australia	Australasia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes
[497] Troelstra et al.(2020)	2020	Associations of MM with outcome	the Netherlands	Europe	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	26	Yes
[498] Tyack et al.(2016)	2016	Study of people with MM	Australia	Australasia	Primary care	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	25	No
[499] Tyack et al.(2018)	2018	Study of people with MM	Australia	Australasia	Primary care	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	25	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[500] Tyack et al.(2018)	2018	Study of people with MM	Australia	Australasia	Primary care	All adults	MCC	Simple counts of diseases	Simple counts of diseases	Self-report	21	Yes
[501] Umegaki et al.(2017)	2017	Associations of MM with outcome	Japan	Asia	Primary care	Only older people	NA	CCI	Weighted index	Medical records and administrative database	19	Yes
[502] Valdivieso et al.(2018)	2018	Study of people with MM	Spain	Europe	Hospitals	All adults	NA	Unclear	Unclear	NA	Unclear	No
[503] van den Brink et al.(2017)	2017	Study of people with MM	the Netherlands	Europe	Care homes	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	56	No
[504] van Walraven et al.(2009)	2009	Examination of MM measures	Canada	North America	Hospitals	All adults	NA	Elixhauser's measure	Weighted index	Medical records and administrative database	30	Yes
[505] van Zon et al.(2020)	2020	Study of people with MM	USA	North America	Community	Only middle-aged	2+	Simple counts of diseases	Simple counts of diseases	Self-report	8	Yes
[506] Vancampfort et al.(2017)	2017	Associations of risk factors with MM	China, Ghana, India, Mexico, Russia, and South Africa	Multiple continents	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	11	Yes
[507] Vasilopoulos et al.(2014)	2014	Examination of MM measures	USA	North America	Community	Middle aged and older	2+	Comorbidity Index	Weighted index	Self-report	19	Yes
[508] Vassilaki et al.(2015)	2015	Associations of MM with outcome	USA	North America	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	17	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[509] Vassilaki et al.(2016)	2016	Associations of MM with outcome	USA	North America	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	17	Yes
[510] Vetrano et al.(2016)	2016	Associations of risk factors with MM	Denmark, Finland, Iceland, Italy, the Netherlands, Norway, United Kingdom, Czech Republic, France, Sweden and Germany, Canada	Multiple continents	Care homes	Only older people	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	13	Yes
[511] Vila-Rodrigue et al.(2013)	2013	Patterns of MM	Canada	North America	Community	All adults but not older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	12	Yes
[512] Villarreal et al.(2015)	2015	Associations of MM with outcome	Panama	South America	Primary care	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes
[513] Violan et al. (2019)	2019	Patterns of MM	Spain	Europe	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	60	Yes
[514] Violan et al. (2014)	2014	Associations of risk factors with MM	Spain	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	146	No
[515] Vitry et al.(2009)	2009	Examination of MM measures	Australia	Australasia	Community	Only older people	NA	Medicines Disease Burden Index (MDBI) and Rx-Risk-V	Weighted index	Medical records and administrative database	46	NA

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[516] Volaklis et al.(2018)	2018	Study of people with MM	Germany	Europe	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes
[517] von Strauss et al.(2000)	2000	Other	Sweden	Europe	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[518] Vos et al.(2013)	2013	Associations of MM with outcome	the Netherlands	Europe	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	21	Yes
[519] Vu et al.(2019)	2019	Associations of MM with outcome	Vietnam	Asia	Hospitals	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[520] Wagner et al.(2019)	2019	Study of people with MM	USA	North America	Hospitals	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	9	Yes
[521] Wallace et al.(2016)	2016	Examination of MM measures	Ireland	Europe	Primary care	Only older people	2+	Simple disease counts, CCI; counts of prescribed medications, Rx-Risk; Barnett conditions count	Both simple counts and weighted measure	Medical records and administrative database	NA	NA
[522] Wang et al.(2009)	2009	Examination of MM measures	USA	North America	Community	Only older people	NA	Romano CCI	Weighted index	Medical records and administrative database	19	Yes
[523] Wang et al. (2018)	2018	Associations of MM with outcome	USA	North America	Community	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	20	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[524] Wang et al. (2017)	2017	Associations of MM with outcome	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes
[525] Wei et al. (2019)	2019	Associations of MM with outcome	USA	North America	Community	Middle aged and older	NA	Multimorbidity weighted index	Weighted index	Self-report	81	Yes
[526] Wei et al. (2018)	2018	Examination of MM measures	USA	North America	Community	Middle aged and older	NA	Multimorbidity weighted index (81) and simple count of diseases (12)	Weighted index	Self-report	81	Yes
[527] Wei et al. (2016)	2016	Examination of MM measures	USA	North America	Community	All adults	NA	Multimorbidity weighted index	Weighted index	Self-report	81	Yes
[528] Wei et al. (2019)	2019	Examination of MM measures	USA	North America	Community	Middle aged and older	NA	Multimorbidity weighted index, CCI and disease count	Weighted index	Self-report	81	NA
[529] Wei et al. (2018)	2018	Examination of MM measures	USA	North America	Community	All adults	NA	Multimorbidity weighted index, CCI and disease count	Weighted index	Self-report	81	NA
[530] Wei et al. (2020)	2020	Examination of MM measures	USA	North America	Community	Middle aged and older	NA	Multimorbidity weighted index, disease counts, CCI, Elixhauser, HRQOL-CI	Weighted index	Medical records and administrative database	81	Yes
[531] Welmer et al. (2012)	2012	Associations of risk factors with MM	Sweden	Europe	Primary care	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[532] Whitson et al. (2016)	2016	Patterns of MM	USA	North America	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	13	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[533] Wijers et al. (2019)	2019	Examination of MM measures	Spain	Europe	Community	Middle aged and older	2+	Simple counts of diseases (DBMA)	Simple counts of diseases	Self-report	21	Yes
[534] Wikstrom et al. (2015)	2015	Associations of risk factors with MM	Finland	Europe	Community	All adults but not older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	6	Yes
[535] Williams et al. (2016)	2016	Associations of MM with outcome	USA	North America	Community	All adults	NA	Simple counts of diseases	Simple counts of diseases	Self-report	9	Yes
[536] Wister et al. (2015)	2015	Examination of MM measures	Canada	North America	Community	Only older people	2+	Wister's measure	Weighted index	Self-report	19	Yes
[537] Woldesemaya t et al. (2018)	2018	Other	Ethiopia	Africa	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	18	Yes
[538] Wong et al. (2016)	2016	Associations of risk factors with MM	USA	North America	Community	All adults	Index score	Gagne's weighted measure	Weighted index	Medical records and administrati ve database	32	Yes
[539] Yang et al. (2014)	2014	Trajectory of MM	Japan	Asia	Community	Only older people	NA	Simple counts of diseases	Simple counts of diseases	Self-report	4	Yes
[540] Yao et al. (2020)	2020	Associations of MM with outcome	China	Asia	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[541] Yorke et al. (2017)	2017	Associations of MM with outcome	USA	North America	Community	Middle aged and older	2+	Simple counts of diseases	Simple counts of diseases	Self-report	7	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[542] You et al. (2019)	2019	Associations of MM with outcome	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	27	Yes
[543] Zekry et al. (2012)	2012	Examination of MM measures	Switzerland	Europe	Hospitals	Only older people	NA	Charlson Comorbidity Index, Cumulative Illness Rating ScaleeGeriatrics, Index of Coexistent Diseases, Kaplan, Geriatric Index of Comorbidity (GIC), and Chronic Disease Score	Weighted index	Medical records and administrative database	NA	NA
[544] Zekry et al. (2010)	2010	Examination of MM measures	Switzerland	Europe	Hospitals	Only older people	NA	Charlson index, cumulative illness rating scale [CIRS], index of coexistent diseases, Kaplan scale, geriatrics index of comorbidity [GIC], and chronic disease score	Weighted index	Medical records and administrative database	NA	NA
[545] Zimmerman et al. (2017)	2017	Study of people with MM	USA	North America	Hospitals	All adults	3+	Unclear	Unclear	NA	Unclear	No
[546] Zielinski et al. (2011)	2011	Associations of MM with outcome	Sweden	Europe	Primary care	Whole population	NA	ACG system	Weighted index	Medical records and administrative database	Unclear	No

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[547] Zhang et al. (2020)	2020	Associations of risk factors with MM	China	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	15	Yes
[548] Zhang et al. (1999)	1999	Examination of MM measures	USA	North America	Hospitals	Only older people	NA	CCI	Weighted index	Medical records and administrative database	17	Yes
[549] Zulman et al. (2015)	2015	Associations of MM with outcome	USA	North America	Hospitals	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	33	Yes
[550] Zielinski et al. (2009)	2009	Examination of MM measures	Sweden	Europe	Primary care	All adults	NA	ACG system	Weighted index	Medical records and administrative database	NA	NA
[551] Miller et al. (1992)	1992	Examination of MM measures	USA	North America	Primary care	Only older people	NA	CIRS-G	Weighted index	Medical records and administrative database	14	Yes
[552] van den Brink et al. (2020)	2020	Study of people with MM	the Netherlands	Europe	Hospitals	All adults	NA	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	Unclear	No
[553] Khanam et al. (2011)	2011	Patterns of MM	Bangladesh	Asia	Community	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	9	Yes
[554] Cornell et al. (2009)	2009	Patterns of MM	USA	North America	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	45	Yes
[555] Guerra et al. (2019)	2019	Examination of MM measures	Canada	North America	Primary care	Only older people	2+	Simple counts of diseases	Simple counts of diseases	Medical records and self-report	17	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[556] Peng et al. (2020)	2020	Examination of MM measures	Taiwan	Asia	Hospitals	Only older people	NA	Machine learning–based multimorbidity frailty index	Weighted index	Medical records and administrative database	38	Yes
[557] Wang et al. (2020)	2020	Examination of MM measures	Canada	North America	Community	Middle aged and older	MCC	Wang's multimorbidity index	Weighted index	Self-report	35	Yes
[558] Canizares et al. (2018)	2018	Associations of risk factors with MM	Canada	North America	Community	All adults but not older people	2+	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes
[559] Cassell et al. (2018)	2018	Prevalence of MM	UK	Europe	Primary care	All adults	2+	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	36	No
[560] Wang et al. (2014)	2014	Prevalence of MM	China	Asia	Community	Whole population	2+	Simple counts of diseases	Simple counts of diseases	Self-report	40	Yes
[561] Wong et al. (2019)	2019	Associations of MM with outcome	Hong Kong	Asia	Community	All Adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	5	Yes
[562] Chung et al. (2015)	2015	Associations of risk factors with MM	Hong Kong	Asia	Community	All Adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	46	Yes
[563] Nicholson et al. (2019)	2019	Patterns of MM	Canada	North America	Primary care	All Adults	MCC	Simple counts of diseases	Simple counts of diseases	Medical records and administrative database	20	Yes
[564] George et al. (2006)	2006	Examination of MM measures	Australia	Australasia	Hospitals	Middle aged and older	NA	MDBI	Weighted index	Medical records and administrative database	20	Yes

Author	Year	Study.Purpose	Country	Continent	Setting	Study.Population	MM.Def	Name.Measure	Type.Measure	Source	No. Con	Listing. Con
[565] Von Korff et al. (1992)	1992	Examination of MM measures	USA	North America	Community	All Adults	NA	CDS	Weighted index	Medical records and administrative database	17	Yes
[566] Puth et al. (2017)	2017	Associations of risk factors with MM	Germany	Europe	Community	All Adults	2+	Simple counts of diseases	Simple counts of diseases	Self-report	17	Yes

Abbreviations: MM: Multimorbidity. NA: Not Applicable. MM.Def: Definition of multimorbidity. No.Con: Number of conditions. Listing.Con: Listing of conditions. CCI: Charlson Comorbidity Index. CIRS-G: Cumulative Illness Rating Scale-Geriatric. CCS: Clinical Classification Software. ACG: Adjusted Clinical Group. CDS: Chronic Disease Score. QOF: Quality and Outcome Framework. MCS: Multisource Comorbidity Score. ICC: Individual Chronic Condition. PBDI: Pharmacy-Based Disease Indicator. GIC: Geriatric Index of Comorbdiity. MDBI: Medication-based Disease Burden Index. FCI: Functional Comorbidity Index. HRQoL-CI: Health-related Quality of Life Comorbidity Index. DBMA: Disease Burden Morbidity Assessment. CI: Comorbidity Index

Table S4: Cross-tabulation

Characteristics	Type of measure			Chi-square test
	Simple count	**Weighted count**	**Total**	
Study purpose				
Trajectories	89%	11%	100%	χ^2=11·87 p=0.008
Outcome	78%	22%	100%	
Risk factors	93%	7%	100%	
Patterns	91%	9%	100%	
Examination of measures	16%	84%	100%	
Study of people with multimorbidity	91%	9%	100%	
Study setting				
Community	86%	14%	100%	χ^2=153·60 p=0.0004
Primary care	74%	26%	100%	
Hospitals	22%	78%	100%	
Care homes	42%	58%	100%	
Source				
Self-report	89%	11%	100%	χ^2=57·00 p=0.0004
Database	46%	54%	100%	

Figure S2: The 67 chronic conditions organised in descending order of the percentage of studies including the condition in the multimorbidity measure

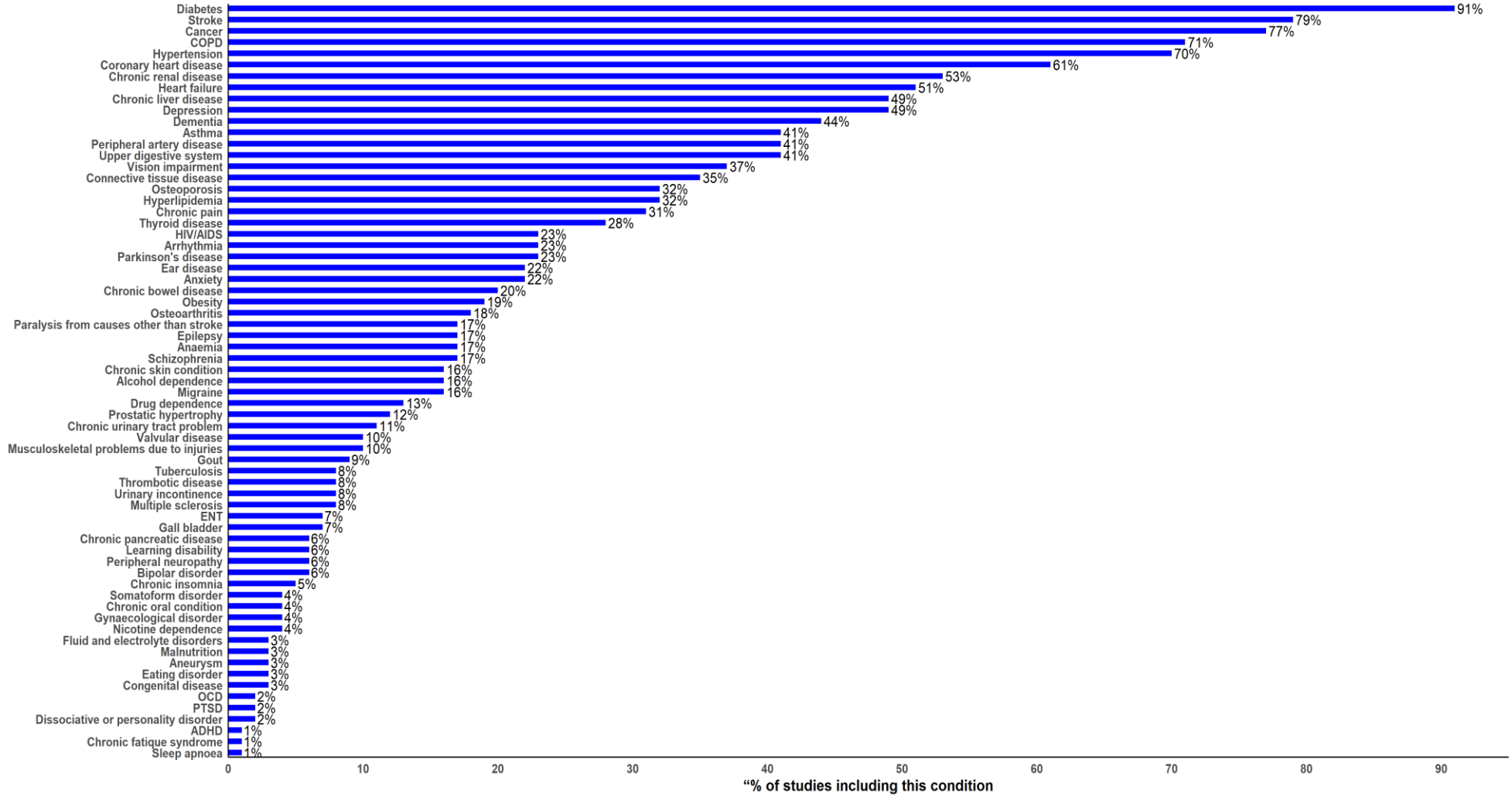


Figure S3: Disability Adjusted Life Years (DALYs) of selected conditions, and percentage of studies including each condition in multimorbidity measurement[567]

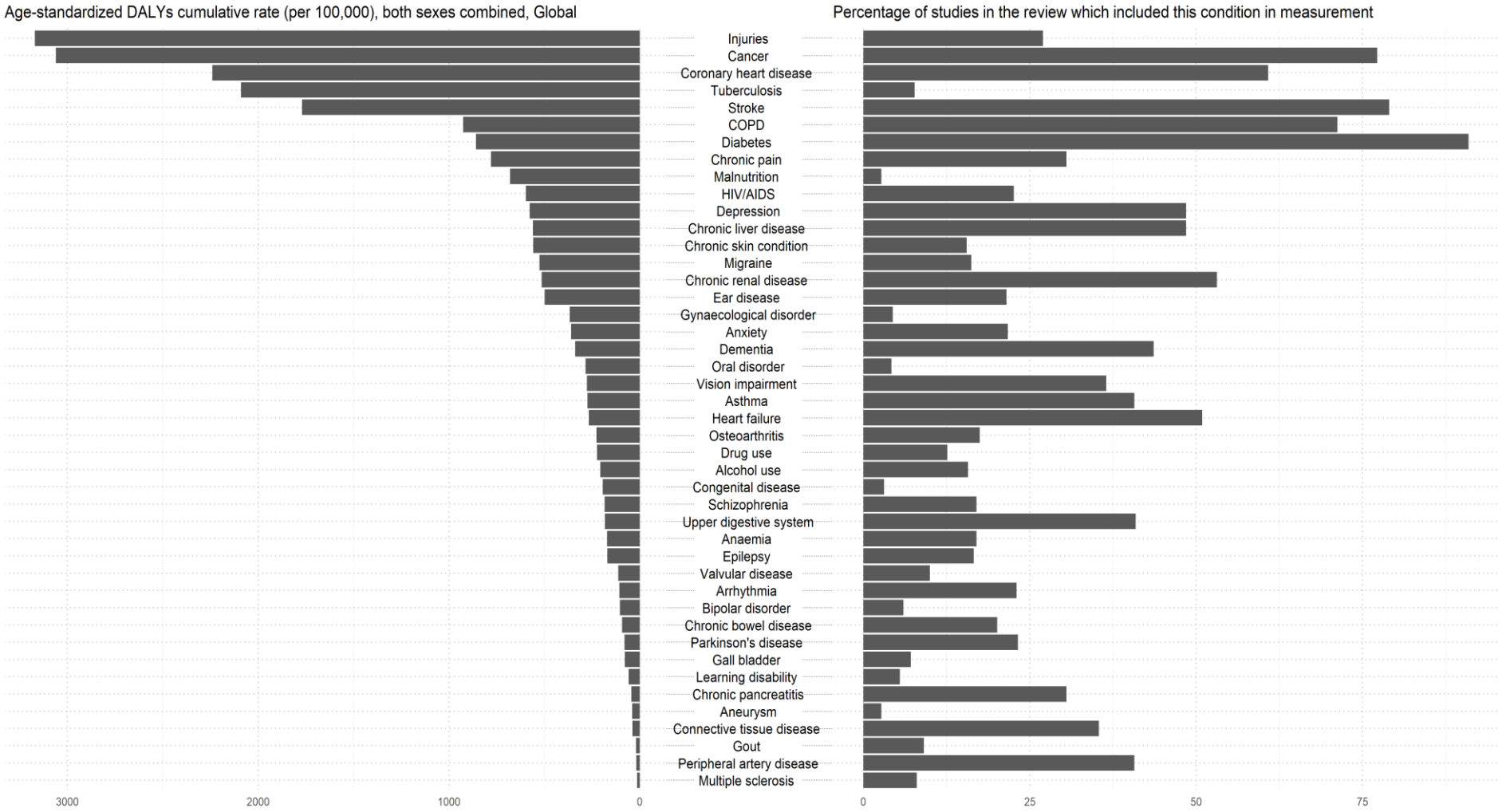


Table S5: Risk of bias assessment (EPHPP domains and overall RoB assessment; and study-specific evaluation of clarity of reporting of multimorbidity measurement)

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[1] Aaby et al. (2019)	Moderate	High	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[2] Aarts et al. (2012)	Moderate	Moderate	Moderate	High	Low	Low	Moderate	Low	Moderate	Yes
[3] Aarts et al. (2011)	Low	High	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	No
[4] Aarts et al. (2011)	Moderate	Moderate	Moderate	High	Low	Low	Moderate	Low	Moderate	Yes
[5] Abizanda et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[6] Agborsangaya et al. (2012)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[7] Agborsangaya et al. (2013)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[8] Agborsangaya et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[9] Ahrenfeldt et al. (2019)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	No
[10] Alimohammadian et al. (2017)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	Yes
[11] Alwhaibi et al. (2015)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	Yes
[12] Angst et al. (2002)	Moderate	Moderate	Moderate	High	Low	High	High	Unclear	High	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[13] Appa et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[14] Adams (2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[15] Adams et al. (2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[16] Ahmadi et al. (2016)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[17] Ahn et al. (2017)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[18] Alonso et al. (2011)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[19] Alonso-Moran et al. (2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[20] Alwhaibi et al. (2015)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	Yes
[21] Amaral et al. (2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[22] An et al. (2016)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[23] Andersson et al.(2018)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	No
[24] Andrade et al. (2010)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[25] Andrews et al. (2001)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[26] Araujo et al. (2018)	Low	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[27] Adeniji et al. (2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[28] Arnold-Reed et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[29] Arokiasamy et al. (2015)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[30] Ashworth et al. (2019)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[31] Arfken et al. (1998)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[32] Assari et al. (2015)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[33] Assari et al. (2015)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[34] Aubert et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[35] Holden et al. (2011)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[36] Violan et al. (2013)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[37] Sinnige et al.(2015)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Moderate	Yes
[38] Christofoletti et al.(2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[39] Aubert et al. (2019)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	No
[40] Aubert et al.(2020)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[41] Cornish et al.(2013)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[42] Zemedikun et al.(2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[43] Wensing et al. (2001)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[44] Forjaz et al.(2015)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[45] Prazeres et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[46] Mounce et al.(2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[47] Taylor et al.(2010)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[48] Vancampfort et al.(2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[49] Vancampfort et al.(2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[50] Aubert et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[51] Autenrieth et al.(2013)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[52] Bahat et al.(2013)	High	High	High	High	High	High	Moderate	Low	High	No
[53] Bahat et al.(2014)	High	High	High	High	High	High	Moderate	Low	High	No
[54] Bahler et al.(2015)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[55] Vancampfort et al.(2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[56] Bahrmann et al.(2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[57] Balbale et al(2016)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[58] Banjare et al.(2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[59] Bao et al.(2019)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[60] Barra et al.(2015)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	No
[61] Bayliss et al.(2015)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[62] Bayliss et al.(2005)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[63] Bayliss et al.(2009)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[64] Bekic et al.(2019)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[65] Beloosesky et al.(2011)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[66] Bernard et al.(2016)	High	Moderate	High	High	Moderate	Low	Moderate	Low	High	No
[67] Bishop et al.(2018)	High	Moderate	Low	High	Moderate	High	Moderate	Low	High	No
[68] Biswas et al.(2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[69] Blakemore et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[70] Blyth et al.(2008)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[71] Bobo et al.(2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[72] Boeckxstaens et al.(2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[73] Boeckxstaens et al.(2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[74] Booth et al.(2014)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[75] Borson et al.(2010)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[76] Bottle et al.(2011)	Low	Moderate	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[77] Bower et al.(2013)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[78] Bowling et al. (2019)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[79] Bravo (2002)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[80] Brenk-Franz et al. (2017)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[81] Brett et al. (2013)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[82] Brett et al. (2014)	Moderate	Moderate	High	High	Moderate	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[83] Brilleman et al. (2013)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[84] Britt et al. (2008)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[85] Broeiro-Goncalves (2019)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[86] Bruce et al. (2010)	High	Moderate	Moderate	High	Low	High	Moderate	Unclear	High	No
[87] Buntinx et al. (2002)	Moderate	High	High	High	High	High	Moderate	Unclear	High	No
[88] Burgers et al. (2010)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[89] Burke et al. (2017)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[90] Buurman et al. (2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[91] Byers et al. (2010)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	No
[92] Byles et al. (2005)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No
[93] Byles et al. (2014)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[94] Bynum et al. (2017)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[95] Bynum et al. (2004)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[96] Calderon-Larranaga et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[97] CalderonUnclearLarranaga et al. (2017)	Moderate	Moderate	Moderate	High	Low	Low	Moderate	Low	Moderate	Yes
[98] Calderon-Larranaga et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[99] Camargo-Casas et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[100] Canevelli et al. (2019)	High	High	High	High	Moderate	High	Moderate	Low	High	Yes
[101] Capisizu et al. (2015)	High	High	High	High	Moderate	High	High	Unclear	High	No
[102] Caracciolo et al. (2013)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[103] Caramello et al. (2019)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[104] Carey et al. (2013)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[105] Cesari et al. (2006)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[106] Chamberlain et al. (2020)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[107] Chan et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[108] Chapleski et al. (1997)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[109] Chaplin et al. (2018)	Low	Low	Moderate	High	Low	High	Low	Low	Low	Yes
[110] Chapman et al. (2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[111] Charlson et al. (2007)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No
[112] Charlson et al. (2008)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[113] Charlson et al. (1987)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[114] Charlson et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[115] Chaudhry et al. (2005)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[116] Chen et al. (2018)	Low	Moderate	High	High	Low	Low	Moderate	Low	Low	Yes
[117] Chen et al. (2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[118] Chen et al. (2011)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[119] Cheung et al. (2013)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[120] Chin et al. (2019)	High	High	High	High	Moderate	High	High	Low	High	Yes
[121] Chong et al. (2012)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[122] Chow et al. (2014)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[123] Chu et al. (2018)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[124] Chudasama et al. (2019)	Moderate	Moderate	Low	High	Moderate	Low	Moderate	Low	Moderate	Yes
[125] Cimarras-Otal et al. (2014)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[126] Clerencia-Sierra et al. (2015)	High	High	Moderate	High	High	High	Moderate	Unclear	High	No
[127] Chen et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[128] Chen et al. (2019)	High	High	Moderate	High	Moderate	High	Moderate	Unclear	High	No
[129] Chen et al. (2010)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[130] Cheng et al. (2020)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[131] Chin et al. (2016)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[132] Clark et al. (2018)	Moderate	Moderate	High	High	High	Low	Moderate	Low	High	No
[133] Collins et al. (2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[134] Contant et al. (2019)	Low	Low	Moderate	High	Moderate	Low	Moderate	Low	Low	Yes
[135] Corrao et al. (2017)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[136] Formiga et al. (2016)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[137] Fortin et al. (2006)	High	High	Moderate	High	Moderate	High	Moderate	Unclear	High	No
[138] Agrawal et al. (2016)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[139] Fortin et al. (2007)	High	High	High	High	Moderate	High	Moderate	Low	High	Yes
[140] Gorup et al. (2017)	High	High	High	High	Moderate	High	Moderate	Low	High	No
[141] Griffith et al. (2018)	Moderate	High	High	High	Moderate	High	Moderate	Unclear	High	No
[142] Gu et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[143] Guido et al. (2014)	High	High	High	High	Moderate	High	Moderate	Low	High	No
[144] Gunn et al. (2012)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[145] Han et al. (2013)	High	High	Moderate	High	Moderate	High	Moderate	Unclear	High	No
[146] Hanlon et al. (2018)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[147] Incalzi et al. (1997)	High	Moderate	Moderate	High	High	High	Moderate	Unclear	High	No
[148] Jansa et al. (2010)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[149] Jantsch et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[150] John et al. (2003)	Moderate	High	Moderate	High	Low	High	Moderate	Low	High	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[151] Johnson-Lawrence et al. (2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[152] Johnston et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[153] Jones et al. (2016)	Low	Moderate	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[154] Jovic et al. (2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[155] Jovic et al. (2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[156] Juul-Larsen et al. (2020)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[157] Hudon et al. (2008)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[158] Hussain et al. (2015)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[159] Hussin et al. (2019)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[160] Hutchinson et al. (2015)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[161] Ie et al. (2017)	High	High	Moderate	High	Moderate	Low	Moderate	Low	High	Yes
[162] Ishizaki et al. (2019)	Moderate	Moderate	Low	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[163] Jackson et al. (2015)	Low	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[164] Jacobi et al. (2004)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[165] Januel et al. (2011)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[166] Danon-Hersch et al. (2012)	Moderate	High	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[167] de Heer et al. (2013)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[168] de Souto Barreto et al. (2014)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[169] Demirchyan et al. (2013)	High	Moderate	Low	High	Moderate	High	Moderate	Low	High	No
[170] Fabbri et al. (2015)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[171] Fabbri et al. (2016)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[172] Farley et al. (2006)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[173] Feng et al. (2018)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[174] Fergusson et al. (1993)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[175] Ferreira Agreli et al (2017)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[176] Fillenbaum et al. (2000)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[177] Finney Rutten et al. (2016)	Moderate	High	Moderate	High	High	High	Moderate	Low	High	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[178] Ford et al. (2019)	Low	Low	Moderate	High	Low	Low	Moderate	Low	Low	No
[179] Kadam et al. (2007)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[180] Kaneko et al. (2019)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	No
[181] Kang et al. (2017)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[182] Gruneir et al. (2016)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[183] Gandhi et al. (2020)	Moderate	Moderate	Moderate	High	High	High	Moderate	Low	Moderate	Yes
[184] Corrao et al. (2019)	Moderate	Moderate	High	High	High	High	Moderate	Low	High	No
[185] Corrao et al.(2020)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[186] Cortaredona et al.(2017)	High	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[187] Costa et al. (2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[188] Cramm et al. (2018)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[189] Crooks et al. (2016)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[190] Crooks et al. (2015)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[191] Dankel et al. (2018)	Moderate	High	High	High	Moderate	High	Moderate	Low	High	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[192] Dankel et al. (2017)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[193] Dattalo et al. (2017)	Low	Moderate	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[194] de Carvalho et al. (2018)	Low	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[195] de Souza Leal Neto et al.(2016)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[196] Verghese et al. (2016)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[197] Der-Martirosian et al. (2013)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	No
[198] Rizzuto et al. (2017)	High	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[199] Rivera-Almaraz et al. (2018)	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	No
[200] Schneider et al. (2012)	High	Moderate	Moderate	High	High	Moderate	Moderate	Unclear	Moderate	Yes
[201] Schneeweiss et al. (2004)	Low	Moderate	Moderate	High	Low	Low	Low	Unclear	Low	Yes
[202] Sara et al.(2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[203] Dhalwani et al. (2017)	Moderate	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[204] Di Bari et al. (2006)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[205] Dias et al. (2015)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[206] DiBonaventura et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	No
[207] Diederichs et al.(2012)	Moderate	Low	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[208] Diez-Manglano et al.(2015)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[209] Dong et al. (2013)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[210] Donze et al.(2013)	Moderate	High	Moderate	High	High	Low	Moderate	Low	High	No
[211] Drewes et al.(2011)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[212] Droomers et al. (2004)	Moderate	High	High	High	High	High	Moderate	Low	High	No
[213] Eakin et al. (2007)	Moderate	Low	Low	High	Low	Moderate	Moderate	Low	Low	Yes
[214] Sangha et al. (2003)	Moderate	Moderate	Moderate	High	Low	Moderate	Moderate	Unclear	Moderate	No
[215] Salman et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[216] Salisbury et al. (2018)	Low	Low	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	No
[217] Rius et al. (2008)	Low	Low	Low	High	Low	High	Moderate	Unclear	Low	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[218] Elixhauser et al. (1998)	Low	Moderate	High	High	Low	Low	Moderate	Unclear	Low	Yes
[219] Eton et al. (2017)	High	Moderate	High	High	Low	High	Moderate	Low	High	No
[220] Fabbri et al. (2015)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[221] Feng et al. (2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[222] Ferrer et al. (2017)	High	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[223] Ferro et al. (2019)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[224] Foguet-Boreu et al. (2015)	Low	High	High	High	Moderate	Moderate	Moderate	Unclear	High	No
[225] Fortin et al.(2016)	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[226] Fortin et al.(2005)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[227] Fortin et al.(2014)	Low	Moderate	Low	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[228] Fortin et al. (2005)	Moderate	Moderate	Low	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[229] Fortin et al. (2010)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[230] Fortin et al. (2017)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[231] Fraccaro et al. (2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[232] Fuchs et al. (1998)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No
[233] Fung et al. (2008)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[234] Gadermann et al. (2012)	Moderate	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	No
[235] Gagne et al. (2011)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[236] Galenkamp et al. (2011)	Low	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[237] Galenkamp et al. (2016)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[238] Gallegos-Carrillo et al.(2009)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[239] Gallo et al.(2016)	Low	Moderate	Moderate	High	High	High	Moderate	Low	High	No
[240] Gamma et al. (2001)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[241] Gaulin et al.(2019)	Low	Moderate	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[242] Gawron et al.(2020)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[243] Ge et al. (2018)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[244] Ge et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[245] Gibbons et al. (2013)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[246] Gili et al. (2010)	Low	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[247] Gnadinger et al. (2018)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[248] Excoffier et al.(2018)	Moderate	Moderate	High	High	Moderate	High	Moderate	Low	Moderate	Yes
[249] Turner Goins et al.(2019)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	No
[250] Gould et al.(2016)	Moderate	Moderate	Moderate	High	High	High	Moderate	Unclear	Moderate	Yes
[251] Griffith et al.(2019)	Low	Low	High	High	Low	Low	Moderate	Low	Low	Yes
[252] Habib et al.(2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[253] Harris et al.(2016)	High	Moderate	High	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[254] Harrison et al.(2017)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[255] Harrison et al.(2012)	High	Moderate	Low	High	Moderate	High	Moderate	Unclear	High	No
[256] Hayek et al.(2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[257] Heller et al.(2009)	Low	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[258] Helvik et al.(2013)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[259] Henninger et al.(2012)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[260] Hernandez et al.(2019)	Moderate	Moderate	Moderate	High	High	High	Moderate	Unclear	Moderate	Yes
[261] Hillen et al.(2017)	Low	Moderate	High	High	High	High	Moderate	Unclear	High	No
[262] Ho et al.(2014)	Moderate	Moderate	High	High	Low	Low	Moderate	Low	Moderate	Yes
[263] Holman et al.(2005)	Low	Moderate	High	High	Low	Low	Moderate	Unclear	Low	Yes
[264] Hopman et al.(2016)	High	Moderate	Moderate	High	High	High	Moderate	Low	High	No
[265] Hu et al.(2019)	Low	Moderate	High	High	Low	Low	Moderate	Low	Low	Yes
[266] Huang et al.(2019)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[267] Hudon et al.(2012)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[268] Katikireddi et al.(2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[269] Kenning et al.(2015)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[270] Khan et al.(2010)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[271] Khan et al.(2019)	Low	Moderate	Low	High	Low	High	Moderate	Low	Low	Yes
[272] Ki et al. (2017)	Low	Moderate	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[273] Kil et al. (2012)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[274] Kilgore et al. (2012)	High	Moderate	High	High	Moderate	Moderate	Moderate	Unclear	Moderate	No
[275] Kiliari et al. (2013)	High	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	No
[276] Kim et al. (2012)	Moderate	Moderate	High	High	Moderate	High	Moderate	Low	Moderate	Yes
[277] Kim et al. (2018)	Low	Moderate	Low	High	Moderate	Low	Moderate	Low	Low	Yes
[278] Kim et al. (2018)	High	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[279] King et al.(2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[280] Kingston et al. (2018)	Low	Moderate	High	High	Moderate	High	Moderate	Unclear	High	Yes
[281] Koyanagi et al.(2018)	Low	Moderate	Moderate	High	Moderate	Low	High	Low	Moderate	Yes
[282] Kriegsman et al. (2004)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[283] Kristensen et al. (2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[284] Kristensen et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[285] Kumar et al. (2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[286] Kunna et al. (2017)	Low	Moderate	Low	High	Moderate	Low	High	Low	Low	Yes
[287] Kusumastuti et al. (2017)	Low	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[288] Kuwornu et al. (2014)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[289] Lai et al. (2019)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[290] Lai et al. (2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[291] Laires et al. (2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[292] Landi et al. (2016)	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[293] Landi et al. (2010)	High	Moderate	Low	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[294] Lang et al. (2015)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[295] Langsted et al. (2020)	Low	Moderate	High	High	High	Low	Moderate	Low	High	No
[296] Laux et al. (2008)	Low	Moderate	High	High	High	Low	Moderate	Low	High	No
[297] Lawson et al. (2013)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[298] Le Cossec et al. (2016)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[299] Lee et al. (2020)	High	Moderate	Moderate	High	High	High	Moderate	Low	High	No
[300] Lee et al. (2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[301] Lee et al. (2007)	Low	Moderate	High	High	Low	Low	Moderate	Low	Low	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[302] Lee et al. (2018)	Low	Moderate	High	High	High	Low	Moderate	Unclear	High	No
[303] Lenzi et al. (2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[304] LePage et al. (2014)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	No
[305] Li et al. (2016)	Low	Low	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[306] Li et al. (2019)	Low	Moderate	Low	High	Moderate	Moderate	Moderate	Low	Moderate	No
[307] Librero et al. (1999)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[308] LiuUnclearAmbrose et al. (2010)	High	Moderate	Moderate	High	High	High	Moderate	Low	High	No
[309] Lobo-Escolar et al. (2008)	Low	Moderate	High	High	High	High	Moderate	Unclear	High	Yes
[310] Loprinzi (2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[311] Loprinzi (2017)	Moderate	Moderate	Moderate	High	High	High	Moderate	Unclear	Moderate	Yes
[312] Lorem et al. (2016)	Moderate	Moderate	Moderate	High	High	High	Moderate	Unclear	Moderate	Yes
[313] Low et al. (2019)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[314] Lu et al. (2011)	Low	High	Moderate	High	Low	Low	Moderate	Unclear	Low	Yes
[315] Lujic et al. (2017)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[316] Lupianez-Villanueva et al.(2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[317] Zhou et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	Low	High	Low	Moderate	Yes
[318] Zhang et al. (2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[319] Yamada et al. (2015)	High	Moderate	Moderate	High	Low	High	Moderate	Low	High	No
[320] Wong et al. (2010)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[321] White (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[322] Weimann et al. (2016)	Low	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[323] Wei et al. (2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[324] Wang et al. (2017)	Low	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[325] Wang et al. (2017)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[326] Wang et al. (2007)	High	Moderate	High	High	Moderate	Low	Moderate	Unclear	High	No
[327] Wang et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[328] Walker et al. (2007)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[329] Wade et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[330] Maciejewski et al. (2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[331] MacKnight et al. (2001)	Moderate	High	High	High	High	Low	Moderate	Unclear	High	No
[332] Marengoni et al. (2016)	Moderate	Moderate	High	High	Moderate	High	Moderate	Low	Moderate	Yes
[333] Marengoni et al. (2009)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[334] Déruaz-Luyet et al. (2017)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[335] Marengoni et al. (2009)	Moderate	Moderate	High	High	Moderate	High	Moderate	Low	Moderate	Yes
[336] Marques et al. (2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[337] Martin-Garcia et al. (2013)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[338] Martinez-Velilla et al. (2014)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[339] Mavaddat et al. (2014)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[340] Mazzella et al. (2010)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[341] McDaid et al. (2013)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	Yes
[342] Md Yusof et al. (2010)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[343] Melis et al. (2014)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[344] Mercer et al. (2016)	Low	Low	Moderate	High	Low	Low	Moderate	Low	Low	No
[345] Min et al. (2007)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	Yes
[346] Min et al. (2014)	Moderate	Moderate	High	High	Low	Low	Moderate	Low	Moderate	Yes
[347] Mnatzaganian et al. (2012)	Low	Moderate	High	High	Low	Low	Moderate	Unclear	Low	Yes
[348] Mokraoui et al. (2016)	Moderate	Moderate	Moderate	High	High	High	Moderate	Low	Moderate	Yes
[349] Momtaz et al. (2010)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[350] Mondor et al. (2018)	Low	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[351] Mondor et al. (2016)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[352] Montes et al. (2020)	High	Moderate	Moderate	High	Low	Low	Moderate	Low	Moderate	Yes
[353] Moore et al. (2014)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[354] Mori et al. (2019)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	No
[355] Mortsiefer et al (2017)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[356] Mueller-Schotte et al. (2020)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[357] Muggah et al. (2012)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	No
[358] Mukherjee et al. (2011)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[359] Nagel et al. (2017)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[360] Nagel et al. (2008)	Low	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[361] Nagl et al. (2012)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[362] Naithani et al. (2010)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[363] Narayan et al. (2017)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[364] New et al. (2017)	High	Moderate	High	High	Moderate	Low	Moderate	Low	High	No
[365] Nguyen et al. (2019)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[366] Niedzwiedz et al. (2019)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[367] Nilssen et al. (2014)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[368] Nobrega et al. (2009)	High	High	High	High	Moderate	High	Moderate	Unclear	High	No
[369] Nunes et al. (2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[370] Nunes et al. (2017)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[371] Nunes et al.(2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[372] Nutzel et al.(2014)	Moderate	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[373] Olaya et al.(2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[374] Olaya et al.(2017)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[375] Olivares et al.(2017)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[376] Olsson et al.(2005)	High	Moderate	Moderate	High	Low	High	Moderate	Low	High	Yes
[377] Ou et al.(2016)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[378] Pache et al.(2015)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[379] Paddison et al.(2015)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[380] Park et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[381] Park et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[382] Parker et al.(2003)	High	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No
[383] Parkerson et al.(1993)	High	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[384] Patel et al.(2006)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[385] Pati et al.(2016)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[386] Pati et al.(2019)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[387] Pati et al.(2017)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[388] Patrick et al.(2001)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[389] Payne et al.(2013)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[390] Peng et al.(2014)	High	High	High	High	High	High	Moderate	Low	High	No
[391] Peng et al.(2020)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[392] Perez et al.(2020)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[393] Perkins et al.(2004)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[394] Pessini et al. (2016)	Moderate	High	High	High	High	High	Moderate	Unclear	High	Yes
[395] Petersen et al.(2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[396] Pfortmueller et al.(2013)	Moderate	Moderate	High	High	High	High	Moderate	Unclear	High	No
[397] Poitras et al.(2012)	High	Low	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[398] Portz et al.(2017)	High	Moderate	High	High	Moderate	Low	Moderate	Low	High	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[399] Pratt et al.(2018)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[400] Prazeres et al.(2015)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[401] Prazeres et al.(2018)	Moderate	Moderate	High	High	High	Low	Moderate	Low	High	Yes
[402] Pressley et al.(1999)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[403] Prior et al. (2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[404] Prior et al.(2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[405] Pruchno et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[406] Pylvalainen et al.(2019)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[407] Quah et al.(2017)	High	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[408] Quail et al.(2011)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[409] Quan et al. (2011)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[410] Quan et al. (2002)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[411] Quan et al. (2005)	Low	Low	Moderate	High	Low	Low	Moderate	Unclear	Low	Yes
[412] Quinones et al.(2019)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[413] Quinones et al.(2016)	Low	Moderate	High	High	Moderate	High	Moderate	Unclear	High	Yes
[414] Quinones et al.(2018)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[415] Quinones et al.(2011)	Low	Moderate	Moderate	High	Low	High	Moderate	Unclear	Moderate	Yes
[416] Rafiq et al.(2019)	Moderate	Low	High	High	Low	Moderate	Moderate	Low	Moderate	No
[417] Ramiarina et al.(2008)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[418] Ramond-Roquin et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[419] Randall et al.(2018)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[420] Ranstad et al.(2017)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	No
[421] Ranstad et al.(2014)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	No
[422] Rast et al.(2014)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[423] Reinke et al.(2019)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[424] Ribeiro et al.(2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[425] Rose et al. (2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[426] Roso-Llorach et al.(2018)	Low	Moderate	High	High	High	Low	Moderate	Low	High	No
[427] Rozzini et al.(2002)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[428] Ruel et al.(2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[429] Ruel et al.(2014)	Moderate	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	Yes
[430] Russell et al.(2020)	Moderate	Moderate	Moderate	High	Low	High	Moderate	Unclear	Moderate	Yes
[431] Ryan et al.(2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[432] Sasseville et al.(2019)	Low	Moderate	Moderate	High	Low	High	Low	Low	Low	Yes
[433] Barnett et al. (2012)	Low	Moderate	Moderate	High	Moderate	Low	Low	Low	Low	Yes
[434] Schafer et al.(2014)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[435] Schafer et al.(2010)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[436] Schamess et al.(2017)	High	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[437] Schilling et al.(2013)	High	Moderate	High	High	Low	Low	Moderate	Unclear	High	No
[438] Schmidt et al.(2016)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[439] Schneeweiss et al.(2001)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[440] Schneeweiss et al.(2003)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[441] Schottker et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[442] Schuttner et al.(2020)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[443] Schuz et al.(2011)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[444] Schuz et al.(2015)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[445] Schuz et al.(2016)	High	Moderate	Moderate	High	Moderate	High	High	Unclear	High	No
[446] Schuz et al.(2014)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	Yes
[447] Schuz et al.(2012)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	Yes
[448] Selim et al.(2004)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[449] Seo et al.(2017)	Low	Moderate	Moderate	High	Low	High	Moderate	Low	Moderate	No
[450] Seo et al.(2019)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[451] van den Bussche et al. (2011)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[452] Shakib et al.(2016)	High	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No
[453] She et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[454] Shih et al.(2015)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[455] Shih et al.(2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[456] Shwartz et al.(1996)	Moderate	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[457] Silay et al.(2017)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	No
[458] Singer et al.(2019)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[459] Singh et al.(2019)	Low	Moderate	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[460] Smith et al.(2008)	High	Moderate	Moderate	High	High	Low	Moderate	Low	High	No
[461] Spangenberg et al.(2011)	Moderate	Moderate	High	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[462] St Sauver et al.(2015)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[463] Stanley et al.(2017)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No
[464] Stanley et al.(2018)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[465] Starfield et al.(2003)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[466] Steel et al.(2019)	Low	Low	Moderate	High	Low	Low	Low	Low	Low	Yes
[467] Steinman et al.(2012)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[468] Stenholm et al.(2015)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[469] Stepanova et al.(2015)	Low	High	High	High	High	High	High	Unclear	High	Yes
[470] Stickley et al.(2020)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	Yes
[471] Stokes et al.(2017)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[472] Streit et al.(2014)	Moderate	Moderate	Moderate	High	High	High	Moderate	Unclear	Moderate	Yes
[473] Strickland et al.(2018)	Moderate	Moderate	High	High	Moderate	High	Moderate	Low	Moderate	Yes
[474] Stubbs et al. (2018)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[475] Stukenborg et al.(2001)	High	Moderate	Moderate	High	High	High	Moderate	Unclear	High	No
[476] Su et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[477] Subramaniam et al.(2019)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[478] Sullivan et al.(2012)	Low	Moderate	Low	High	Moderate	Low	Moderate	Unclear	Moderate	No
[479] Sundararajan et al.(2004)	Low	Moderate	Moderate	High	Low	Low	Moderate	Unclear	Moderate	Yes
[480] Sundararajan et al.(2007)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[481] Sundstrup et al.(2017)	Low	Moderate	High	High	Moderate	High	Moderate	Unclear	High	Yes
[482] Susser et al.(2008)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[483] Tai et al.(2006)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[484] Takahashi et al.(2016)	Moderate	Moderate	High	High	High	Low	Moderate	Low	High	No
[485] Taleshan et al.(2018)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[486] Tan et al.(2013)	High	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[487] Tetzlaff et al.(2017)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	Yes
[488] Thavorn et al.(2017)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[489] Theou et al.(2012)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[490] Thompson et al.(2015)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[491] Thygesen et al.(2011)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[492] Tinetti et al.(2011)	Low	Moderate	High	High	High	High	Moderate	Unclear	High	No
[493] Tinetti et al.(2012)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	No
[494] Tinetti et al.(2015)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[495] Tinetti et al.(2019)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[496] Tooth et al.(2008)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[497] Troelstra et al.(2020)	High	Moderate	High	High	Moderate	Low	Moderate	Unclear	High	Yes
[498] Tyack et al.(2016)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[499] Tyack et al.(2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[500] Tyack et al.(2018)	High	Moderate	High	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[501] Umegaki et al.(2017)	High	Moderate	Moderate	High	High	High	Moderate	Low	High	No
[502] Valdivieso et al.(2018)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[503] van den Brink et al.(2017)	High	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[504] van Walraven et al.(2009)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[505] van Zon et al.(2020)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[506] Vancampfort et al.(2017)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[507] Vasilopoulos et al.(2014)	Moderate	Moderate	Moderate	High	Low	High	Moderate	Unclear	Moderate	Yes
[508] Vassilaki et al.(2015)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[509] Vassilaki et al.(2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[510] Vetrano et al.(2016)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes
[511] Vila-Rodrigue et al.(2013)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[512] Villarreal et al.(2015)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[513] Violan et al. (2019)	Low	Moderate	Moderate	High	High	Low	Moderate	Low	Moderate	Yes
[514] Violan et al. (2014)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[515] Vitry et al.(2009)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[516] Volaklis et al.(2018)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[517] von Strauss et al.(2000)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[518] Vos et al.(2013)	Moderate	Moderate	High	High	Moderate	High	Moderate	Low	Moderate	No
[519] Vu et al.(2019)	High	Moderate	High	High	Moderate	High	Moderate	Low	High	No
[520] Wagner et al.(2019)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[521] Wallace et al.(2016)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[522] Wang et al.(2009)	Low	Moderate	Moderate	High	High	Low	Moderate	Unclear	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[523] Wang et al. (2018)	Moderate	Moderate	Low	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[524] Wang et al. (2017)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[525] Wei et al. (2019)	Low	Moderate	Low	High	High	High	High	Low	High	No
[526] Wei et al. (2018)	Low	Moderate	Moderate	High	Moderate	High	High	Low	High	No
[527] Wei et al. (2016)	Low	Moderate	Moderate	High	Moderate	High	High	Unclear	High	No
[528] Wei et al. (2019)	Low	Moderate	Moderate	High	Moderate	High	High	Low	High	No
[529] Wei et al. (2018)	Low	Moderate	Moderate	High	Moderate	High	High	Low	High	No
[530] Wei et al. (2020)	Moderate	Moderate	Moderate	High	Moderate	High	High	Low	Moderate	No
[531] Welmer et al. (2012)	Moderate	Moderate	Moderate	High	Low	High	High	Unclear	High	No
[532] Whitson et al. (2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	No
[533] Wijers et al. (2019)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[534] Wikstrom et al. (2015)	Low	Moderate	Moderate	High	Low	Low	Moderate	Low	Low	Yes
[535] Williams et al. (2016)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	No
[536] Wister et al. (2015)	Low	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[537] Woldesemayat et al. (2018)	High	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[538] Wong et al. (2016)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[539] Yang et al. (2014)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[540] Yao et al. (2020)	Moderate	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[541] Yorke et al. (2017)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[542] You et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[543] Zekry et al. (2012)	Moderate	Moderate	Moderate	High	Moderate	Low	High	Unclear	Moderate	Yes
[544] Zekry et al. (2010)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[545] Zimmerman et al. (2017)	Low	Low	Moderate	High	Moderate	High	Moderate	Low	Moderate	No
[546] Zielinski et al. (2011)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	No
[547] Zhang et al. (2020)	Moderate	Moderate	Low	High	Moderate	Low	Moderate	Low	Moderate	Yes
[548] Zhang et al. (1999)	High	Moderate	High	High	Moderate	Low	Moderate	Unclear	High	Yes
[549] Zulman et al. (2015)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	No
[550] Zielinski et al. (2009)	Low	Moderate	High	High	Moderate	Low	Moderate	Low	Moderate	No

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[551] Miller et al. (1992)	High	High	High	High	Moderate	High	Moderate	Unclear	High	Yes
[552] van den Brink et al. (2020)	High	Moderate	High	High	Moderate	Low	Moderate	Low	High	No
[553] Khanam et al. (2011)	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[554] Cornell et al. (2009)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[555] Guerra et al. (2019)	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	Low	Moderate	Yes
[556] Peng et al. (2020)	Low	Moderate	Moderate	High	Moderate	Low	Moderate	Low	Moderate	Yes
[557] Wang et al. (2020)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	Yes
[558] Canizares et al. (2018)	Moderate	Moderate	Low	High	Moderate	High	Moderate	Low	Moderate	Yes
[559] Cassell et al. (2018)	Low	Moderate	High	High	Moderate	Moderate	Moderate	Low	Moderate	No
[560] Wang et al. (2014)	Low	Moderate	Low	High	Low	Low	Low	Low	Low	Yes
[561] Wong et al. (2019)	High	Moderate	Moderate	High	Moderate	High	Moderate	Unclear	Moderate	Yes
[562] Chung et al. (2015)	Low	Moderate	Moderate	High	Moderate	Moderate	Moderate	Unclear	Moderate	Yes
[563] Nicholson et al. (2019)	Low	Moderate	High	High	Moderate	High	Moderate	Low	High	Yes
[564] George et al. (2006)	High	Moderate	High	High	Moderate	High	Moderate	Unclear	High	Yes

Author	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Publication bias	Conflict of interest	Overall risk of bias	Clear reporting of MM measurement and definition
[565] Von Korff et al. (1992)	Low	Moderate	High	High	Moderate	Low	Moderate	Unclear	Moderate	Yes
[566] Puth et al. (2017)	Moderate	Moderate	Moderate	High	Moderate	Moderate	Moderate	Low	Moderate	Yes

Table S6: Overall risk of bias and transparent reporting of multimorbidity measurement

Overall risk of bias* **Transparent reporting of MM measure and definition**	**Low**	**Moderate**	**High**
Yes (n=379)	36 (9%)	318 (84%)	25 (7%)
No (n=187)	4 (2%)	101 (54%)	82 (44%)

* Evaluated using the Effective Public Health Practice Project quality assessment tool[568]

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